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Assessment of 1977 Water Quality Conditions in the Upper Potomac Estuary

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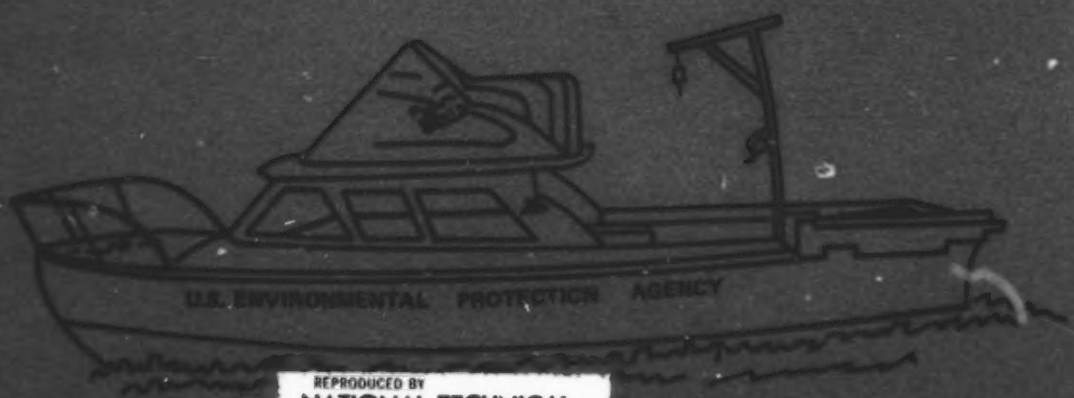

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16. ABSTRACT

A multi-objective water quality monitoring program was conducted in the Potomac Estuary from July to September 1977 by the Annapolis Field Office, U.S.E.P.A. This program, which was primarily intended and designed to update and refine our existing knowledge base, was comprised of slack water sampling, wastewater effluent sampling, and a series of special studies to further describe different facets of the dissolved oxygen budget including some algal related impacts. This report presents all of the data collected during the study along with an enumeration of the findings and conclusions that were based on a detailed analysis of this data.

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ASSESSMENT OF 1977 WATER QUALITY CONDITIONS IN THE UPPER POTOMAC ESTUARY

July 1978

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and
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Chapter 1

INTRODUCTION

The water quality problems of the Potomac in the Washington area have been recognized since the days of President Lincoln. Most of the difficulties at that time manifested themselves as sewage related odors which were abundant on warm summer evenings. It was not until the 1930's that treatment facilities were constructed to alleviate the obvious odor problems and less obvious potential health hazards. Since that time, there has been a continual race between expanding population and construction of treatment works in order to adequately treat the increased wasteloads. Needless to say, treatment facilities still lag behind current and anticipated needs in the Washington Metropolitan Area.

A major objective of the Water Quality Act and its amendments is to "maintain the physical, chemical and biological integrity of the Nation's waters". In the 1950's and 60's, changes in growth of aquatic plants in the Potomac were documented. These biological perturbations were indicative of more basic changes taking place in the physical and chemical environment supporting these aquatic plants. Such biological changes serve as barometers pointing to ecological imbalance within the supporting environment, in this case the Potomac Estuary.

Extensive field studies in the Potomac Estuary were conducted by EPA from 1966 to 1970. These studies pointed out the two major water quality problems existing during that period.

These were an oxygen deficit brought about by discharge of organic wastes and excessive eutrophication brought about by overenrichment of the estuary with nutrients, particularly nitrogen and phosphorus. These studies resulted in the publication of Technical Report 35, which documented the scientific efforts carried out up to that time by EPA's Annapolis Field Office (AFO).

Now, nearly a decade later, these problems are receiving increased attention from regional planners, as attempts to find a solution have grown more complex. The water quality problems of the Potomac Estuary must be considered along with other local environmental issues, such as: water supply needs incorporating a low flow policy, pressure to rerate treatment capacity at Blue Plains, land treatment alternatives, and other legitimate concerns that must somehow be orchestrated into an overall regional management plan, which is at the same time rational, cost-effective, and meets the needs of the public.

It is within this framework of competing uses of the Potomac and conflicting needs of the public that EPA designed a two-year water quality study to update the available data base and provide current information on the status of the Potomac Estuary. Our studies will not answer the many questions raised by the various constituencies served by the Potomac, but they will provide factual documentation on the river's health and an indication of the water quality trends evolving. Such information is basic to the decision maker in formulating the available options from which a workable decision can be made. It is this foundation

of scientific reality that we are attempting to investigate and document.

This report is intended to present the information gained from the first half of the current two-year study effort. The field phase was performed during the summer of 1977 and the findings and conclusions herein evolved during the data interpretation and analysis phase that followed. Tabulations of the raw data along with numerous graphs depicting this data are contained throughout the text and in the Appendix. The ongoing usage of this data within the context of mathematical modeling and for updating portions of Technical Report 35 will be documented at a later time.

The specific objectives associated with this intensive study of the Potomac Estuary's water quality are as follows:

Principal Objective

Provide the first phase of an updated technical data base that will be necessary to address the denitrification deferral issue at Blue Plains.

Secondary Objectives

1. Provide data for updating the verification and improving the predictive reliability of AFO's existing mathematical model of the Potomac Estuary.
2. Determine the response of the Potomac Estuary to the upgraded treatment currently in existence at Blue Plains.
3. Provide a basis for establishing water quality trends with particular emphasis on a comparison

with data collected during the critical period of 1965 - 1970.

4. Define current point source nutrient and oxygen demanding loads entering the Potomac Estuary along with those being contributed from the Upper Basin.
5. Monitor the impact of a storm event in the MWA on the widespread quality characteristics (as opposed to high frequency monitoring for localized effects) of the Estuary.
6. Determine the magnitude of selected herbicides entering the Estuary from upstream and significant point sources, and their extent in the Estuary itself.

Chapter II

DESCRIPTION OF MONITORING PROGRAM

This intensive monitoring program, conducted during the period of July 18 to September 8, was comprised of three distinct but interrelated phases: (Each of these phases will be discussed below.)

A. Ambient Water Quality Monitoring

During six different weeks of the study period, two boat runs, each following a slack water tide condition, were made from the Route 301 Bridge (river mile 67.4) to Chain Bridge (river mile 0.0). The stations sampled enroute, along with their river miles and station number, are presented in Table 1. Because of time constraints, these stations were sampled only within the main channel and near the surface (i.e. no transect type data was obtained). Shown in Table 2 are the approximate starting and ending times for each run, and the significant rainfall events that occurred during the study period. As can be seen, about an equal number of low water and high water slack conditions were sampled.

The following is a list of parameters that were analyzed in conjunction with the ambient monitoring. All of these parameters were measured routinely at every sampling location (with the exception of herbicides, which were done only twice), as well as ultimate (20 day) BOD and phytoplankton counts, which were done on a selective basis.

TABLE 1

1977 POTOMAC ESTUARY SAMPLING STATIONS

Station Number	Name	RMI*
P-8	Chain Bridge	0
P-4	Above Windy Run (opposite Georgetown Reservoir	1.90
1	Key Bridge	3.35
1-A	Memorial Bridge	4.85
2	14th Street Bridge	5.90
3	Hains Point	7.60
4	Bellevue	10.00
5	Woodrow Wilson Bridge	12.10
5-A	Rosier Bluff	13.60
6	Opposite Broad Creek	15.20
7	Fort Washington (Piscataway)	18.35
8	Dogue Creek - Marshall Hall	22.30
8-A	Opposite Gunston Cove	24.30
9	Chapman Point - Hallowing Point	26.90
10	Indian Head	30.60
10-B	Deep Point - Freestone Point	34.00
11	Possum Point	38.00
12	Sandy Point	42.50
13	Smith Point	45.80
14	Maryland Point	52.40
15	Opposite Nanjemoy Creek	58.55
15-A	Mathias Point	62.80
16	Route 301 Bridge	67.40

*Miles below Chain Bridge

TABLE 2

POTOMAC SLACK WATER RUNS

JULY - SEPTEMBER, 1977

Date	Tide	Start Time	End Time	Remarks
7/17				Rain - .24"
7/18	LWS	1125	1700	
7/20	LWS	1245	1710	
7/21				Rain - .59"
7/25	HWS	1100	1505	Rain - .30"
7/27	LWS	0855	1410	
8/01	LWS	1145	1610	Rain - 1.08"
8/03	HWS	0830	1301	
8/05				Rain - .33"
8/14				Rain - 1.20"
8/22	HWS	1035	1540	
8/24	HWS	1130	1535	Rain - 1.23". Fish kill between Broad Creek and Piscataway Creek
8/29	*	1055	1512	
8/30				Rain - .40"
8/31	HWS	0910	1313	
9/06	HWS	1245	1700	
9/08	LWS	0930	1335	Fish kill between Broad Creek and Piscataway Creek

*Missed LWS

Nitrogen Series

TKN
NH_3
$NO_2 + NO_3$

Phosphorus Series

Total PO_4 (filtered and unfiltered)
Inorganic PO_4 (filtered and unfiltered)

Carbon Series

Total C
Total Organic C

Biological

Chlorophyll a
Phytoplankton Counts & Identification

Physical

Temperature
Turbidity
Secchi Disc

Other Chemicals

pH
BOD_5
BOD ultimate
DO
Salinity

Selected Herbicides

Atrazine
Simazine

B. STP Effluent Monitoring

A 24 hour composite effluent sample was obtained from each of the major wastewater treatment plants (collected by plant operators) in the WMA during the same days that the slack water boat runs were being performed. These samples were preserved on ice and returned to the AFO laboratory for analyses. The

parameters that were analyzed included the nitrogen, phosphorus, and carbon series (as contained in the aforementioned parameter list) along with BOD_5 and BOD_{ult} on a once-per-week basis. In addition, herbicide analyses were completed on one occasion. The following is a list of the facilities that were sampled during this study:

Arlington	Fairfax Co. - Pohick Creek
Alexandria	Fairfax Co. - Dogue Creek
Blue Plains	Fairfax Co. - Hunting Creek
Piscataway	Fairfax Co. - Westgate Creek

At the time these STP samples were collected, AFO personnel obtained a representative flow measurement in order that mass loading rates could be computed.

C. Special Studies

Several special studies were incorporated in this monitoring program to address the eutrophication state of the Potomac and its relationship to the prevailing DO values that were being measured. Much of the design and methodology employed in these special studies was for the purpose of better defining various model inputs, as required by its representation of the DO budget. Practically all of these studies were performed before, in the Potomac, with a high degree of success.

1. Algal Elemental Composition Analysis

Concentrated samples of the algal cells were collected at different times, and at different locations in order to determine the relative quantities of carbon, nitrogen, and phosphorus actually contained within the cellular material. This information would

have value in ascertaining the nutritional requirements of the algae, and in interpreting whether or not a nutrient limited situation existed.

2. Bioassay Experiments

Dr. George Fitzgerald, University of Wisconsin, developed several algal bioassay procedures for demonstrating whether the environment has supplied limited or surplus quantities of nutrients. These tests rely on in-situ algae but can be performed in a laboratory by measuring surplus phosphorus uptake, the enzyme alkaline phosphatase, and the ammonia absorption potential under dark conditions. The algal elemental composition analysis and Dr. Fitzgerald's bioassay experiments are very complementary in assessing the impact of nutrients on algal growth.

3. Light and Dark Bottle Studies

Both clear and opaque bottles were submerged at two different depths (in and below the euphotic zone) and at several different locations within the algal bloom for a period of 4-6 hours. The differences in the oxygen content of the bottles can be used to estimate the effects of algal photosynthesis and respiration. If one knows the ambient chlorophyll concentrations, these P and R rates can be expressed very conveniently on a per ug chlorophyll basis.

4. Benthic Oxygen Demand Studies

AFO had previously designed and utilized a benthic respirometer that could be applied in estuarine environments, so long as the water depths did not exceed 15-20 feet. This respirometer was "planted" at several locations in the Potomac Estuary for

at least one hour, and periodic DO readings within the chamber were obtained. The magnitude of the DO variations as a function of time constitutes an indication of the benthic oxygen demand rate. One inherent assumption of this procedure is that the benthic rate proceeds much quicker than the rate of bacterial respiration within the water column.

5. Long Term BOD/Nitrification Rate Study

Since the characteristics of the treated wastewater being discharged to the Potomac Estuary have changed significantly during the past few years (particularly in the case of Blue Plains), it was believed that previous estimates of both the carbonaceous and nitrogenous oxidation rates may no longer be valid; therefore, long term (i.e. 20 days) incubated bottle tests in the laboratory were performed on a weekly basis using river samples, STP effluent samples, and samples of the water entering the estuary at Chain Bridge. An adequate number of DO measurements were obtained from both inhibited and noninhibited samples to distinguish the individual reaction rates and ultimate BOD values.

6. Diurnal Transect Sampling

Three stations were selected for cross-sectional (transect) sampling at hourly intervals, for a total period of 24 hours. Data of this nature is invaluable for assessing the impact of algae on DO concentrations throughout the water column. However, since this diurnal sampling was conducted at a fixed point, the tidal effects had to be accounted for.

7. Drogue Studies

In order to obtain additional data related to a semi-

diurnal DO cycle, but without having to consider the troublesome tidal effects, two special studies were performed wherein a floating drogue identifying a parcel of water was followed. Hourly surface sampling was conducted while following the drogue with samples being analyzed for DO and Chlorophyll.

It should be noted that separate reports, documenting the special laboratory studies relating to algae and oxidation rates, have been prepared and published by AFO.*

*Algal Nutrient Studies in the Potomac Estuary, Joseph Lee Slayton & E. R. Trovato
Carbonaceous and Nitrogenous Demand Studies in the Potomac Estuary, Joseph Lee Slayton & E. R. Trovato

Chapter III

FINDINGS AND CONCLUSIONS

A. General

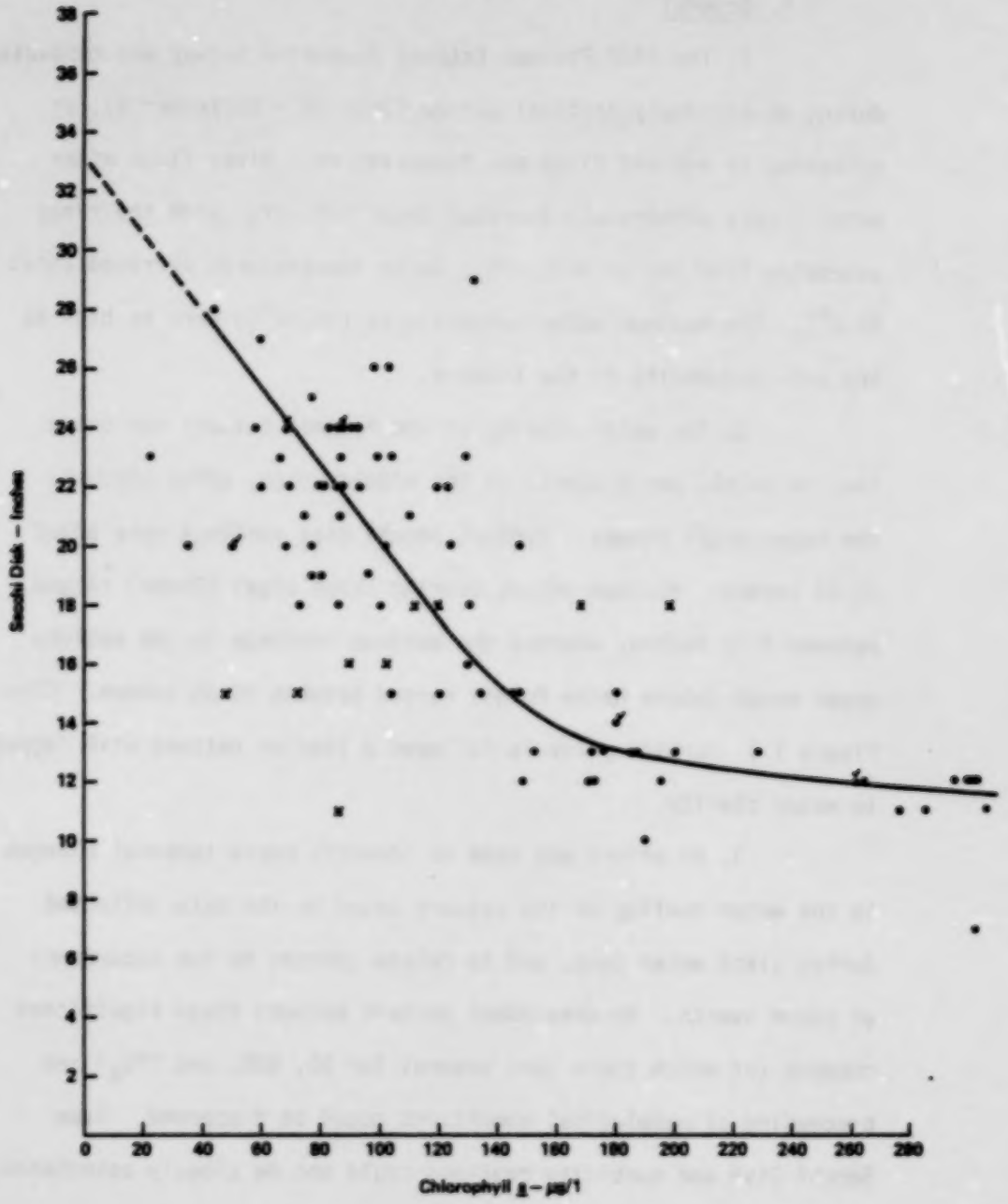
1. The 1977 Potomac Estuary Intensive Survey was conducted during an extremely critical period (July 18 - September 8), as evidenced by ambient flows and temperatures. River flows after water supply withdrawals averaged about 1500 cfs, with the range extending from 940 to 3600 cfs. Water temperatures averaged about 27.6°C. The maximum water temperatures (30-31°C) were as high as any ever documented in the Estuary.

2. The water clarity of the Potomac Estuary was quite low, as usual, particularly in the middle reach, which supports the major algal blooms. Typical Secchi Disk readings were about 20-24 inches. Minimum values (during large algal blooms) ranged between 7-12 inches, whereas the maximum readings in the extreme upper reach (above Hains Point) ranged between 30-35 inches. (See Figure 1.) Turbidity levels followed a similar pattern with respect to water clarity.

3. An effort was made to identify rapid temporal changes in the water quality of the Estuary based on the data collected during slack water runs, and to relate changes to the occurrence of storm events. No consistent pattern between these significant changes (of which there were several for DO, BOD, and TPO_4) and preceeding climatological conditions could be discerned. Even Secchi Disk and turbidity readings could not be closely associated

Figure 1

SECCHI DISK VS. CHLOROPHYLL a
POTOMAC ESTUARY — PISCATAWAY CR. TO POSSUM PT.
(1977 DATA)



with particular storm events. This is not intended to imply that storm water and/or combined sewer overflows do not adversely affect the Estuary, but that these effects may be masked by the various "in-stream" reactions and transport processes taking place, or possibly, that the sampling did not occur at the most opportune time.

4. Numerous regression/correlation analyses were performed using data (see Table A-1) for each of the major parameters monitored during this study. Those which yielded statistically significant results are shown below:

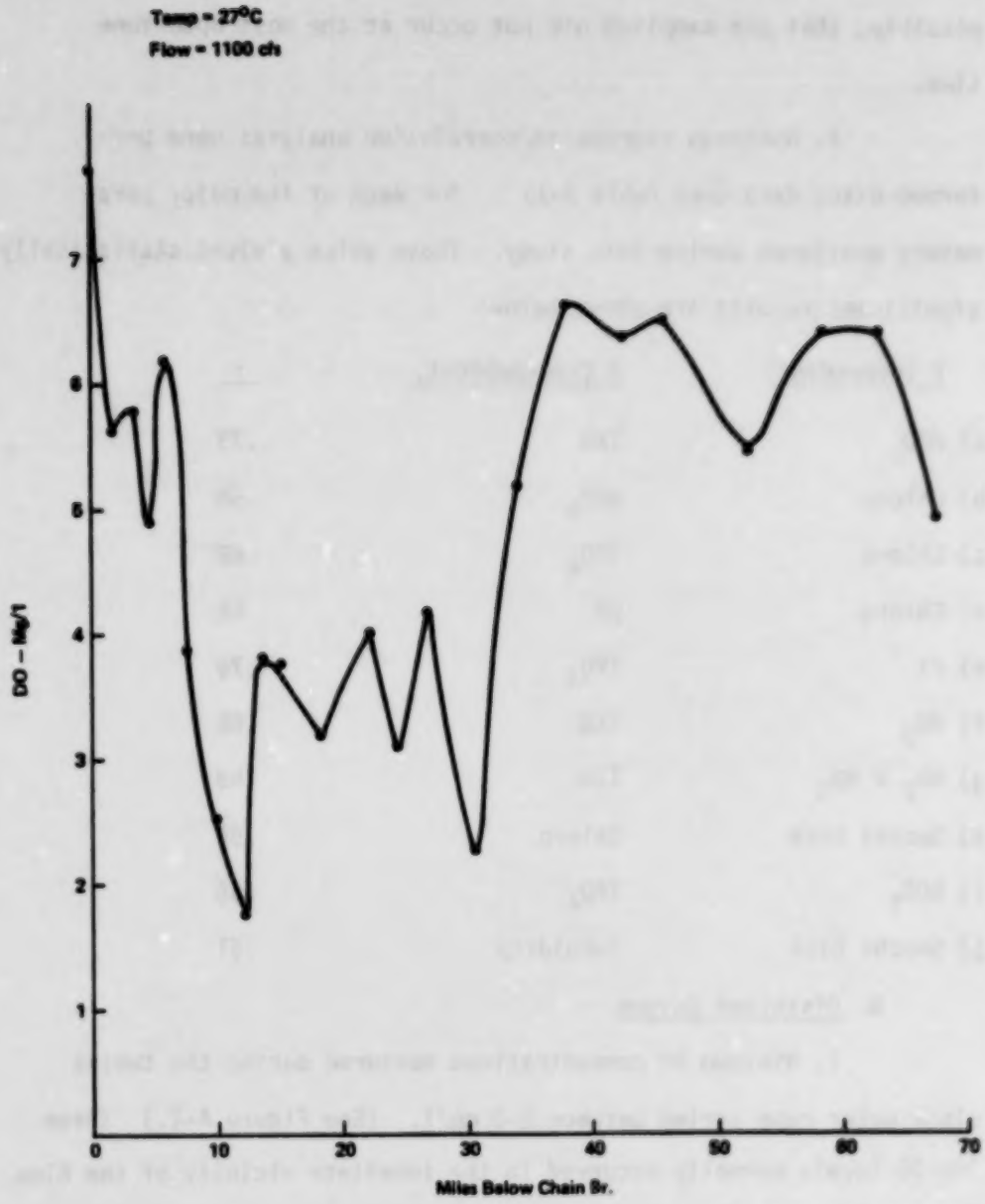
Y (dependent)	X (independent)	r
a) BOD_5	TKN	.73
b) Chloro	BOD_5	.58
c) Chloro	TPO_4	.62
d) Chloro	pH	.66
e) Pi	TPO_4	.76
f) NH_3	TKN	.68
g) NO_2 + NO_3	TKN	.58
h) Secchi Disk	Chloro	.54
i) BOD_5	TPO_4	.55
j) Secchi Disk	Turbidity	.51

B. Dissolved Oxygen

1. Minimum DO concentrations measured during the twelve slack water runs varied between 2-3 mg/l. (See Figure A-1.) These low DO levels normally occurred in the immediate vicinity of the Blue Plains STP. The most critical DO profile was observed on September 8. (See Figure 2)

Figure 2

DO PROFILE
POTOMAC ESTUARY
SEPT. 8, 1977



2. Based upon a statistical analysis of intensive type data collected in the Potomac Estuary during 1965, 1968, 1969, and 1970, as well as the 1977 data, it can be concluded that DO concentrations in the critical reach downstream of Blue Plains have, in fact, improved with time. While difficult to quantitate because of data anomalies and limitations, it appears that on the average, DO levels have increased by about 1.0-2.0 mg/l. All of this data was collected at surface stations having similar algal bloom intensities, and was taken during low flow and high temperature conditions, making the data as comparable as possible.

3. A series of light and dark bottle DO analyses were performed at depths of 1 foot and 6 feet between Broad Creek and Indian Head. (See Table 3.) The purpose of this special study was to estimate representative rates of algal photosynthesis and respiration. Although a considerable amount of variability occurred, the data was averaged and the following rates resulted:

P - 0.0140 mg O_2/ug Chloro/hr

R - 0.0015*mg O_2/ug Chloro/hr

*It was estimated that about 25% of this total respiration rate was attributable to bacterial respiration, producing a net algal respiration rate of 0.0011 mg O_2/ug Chloro/hr.

These rates, it should be noted, compared quite well with the original values presented in Technical Report 35 and used in the Dynamic Estuary Model (P = 0.012 and R = 0.0008 mg O_2/ug Chloro/hr) along with a euphotic depth of 2.0 feet.

1977 POTOMAC PRODUCTIVITY STUDY

Station	Date	Chloro a (µg/l)	Initial DO (mg/l)	Depth (ft)	Time (hr)	DO Light (mg/l)	DO Dark (mg/l)	ΔDO Light - Initial (mg/l)	ΔDO Initial - Dark (mg/l)		P (mg O_2/µg Chloro/hr.)	R (mg O_2/µg Chloro/hr.)		P/R
9 - Hallowing Point	8/08	31.5	10.59	surf	4	16.66	10.61	6.07	----		0.0480	--------		8:1
				6	4	11.79	9.85		0.74			0.00580		
10A - Buoy 5 below Indian Hd.	8/08	169.5	16.27	surf	4	18.94	14.18	2.67	2.09		0.0040	0.00300		2:1
				6	4	11.19	14.93		1.34			0.00200		
7 - Piscataway	8/10	69.0	5.00	1	4	6.10	4.45	1.10	0.55	0.35	0.0040	0.00200	.0016	4:1
				1	6	8.26	4.44	3.26	0.56		0.0080	0.00135		
				6	4	5.49	4.90		0.10			0.00036	.0004	16:1
				6	6	9.13	4.81		0.19			0.00046		
8 - Dogue Creek	8/11	52.5	6.61	1	6	6.50	6.08	----	0.53	0.45		0.00168	.0017	10:1
				1	4	10.28	6.20	3.67	0.41		0.0175	0.00195		
				6	6	6.55	6.12		0.49			0.00155		
				6	4	11.61	13.18							
8A - Gunston Cove	8/11	165.0	11.66	1	6	10.83	7.58	----	4.08	0.36		0.00410		11:1
				1	4	16.40	11.60	4.74	0.06		0.0072	0.00010		
				6	6	10.43	11.01		0.65			0.00065		
				6	4	11.60	11.66		0			0		
6 - Broad Creek	8/16	61.5	2.98	1	3	5.31	2.69	2.33	0.29	0.4	0.0126	0.00160	.0015	10:1
				1	6	8.71	2.54	5.73	0.44		0.0155	0.00120		
				6	3	2.90	2.62		0.36			0.00190		
				6	6	2.73	2.44		0.54			0.00150		
										Use	0.0140	0.00150*		9.3:1

Table 3

*Assume 0.1 mg/l DO depletion in dark bottle due to bacterial respiration
(3 mg/l O_2 demand * .2/day rate *1/6 day

Total DO depletion = 0.4 mg/l

∴Algal respiration = 75%. Bacterial respiration = 25%

Assume further that of the total 0.0015 respiration, 0.0011 is actually due to the algae with the remainder (0.0004) being of bacterial origin.

4. The oxygen production rate observed on August 16 between 0600 hours and 1200 hours was +0.0020 mg O_2/ug Chloro/hr. (See item 7) The results of a light/dark bottle study performed during this time period within the same reach of the Potomac Estuary was used for comparison purposes. Assuming a water depth of 15 feet and a euphotic zone of 2.0 feet, the P and R rates (0.014 and 0.0015 mg O_2/ug Chloro/hr) translate to a net oxygen production rate of +0.0004 mg O_2/ug Chloro/hr. Assuming a water depth of 25 feet and a euphotic zone of 6.0 feet, the same P and R rates translate to a net oxygen production rate of +0.0019 mg O_2/ug Chloro hr, which compares very favorably with the observed production rate. (See Table 4)

5. An oxygen balance was developed utilizing the average P and R rates obtained from the light and dark bottle studies. If a euphotic zone of 2.0 feet is assumed, a zero net production of oxygen is expected to occur when the water depth is about 13 feet. Greater water depths will produce a net depletion of oxygen, whereas, lesser water depths will produce a net addition of oxygen. The actual quantities of oxygen added or consumed will, however, be a function of the chlorophyll level. If a euphotic zone of 4.0 feet is assumed, and if it is further assumed that the same P rate applies, there will be a net production of oxygen even when the water depths are 25 feet. (See Table 5)

6. Seven measurements of the sediment oxygen demand rate were made using a specially designed benthic respirometer. The results are presented below:

Table 4

ANALYSIS OF DIURNAL DO VARIABILITY

POTOMAC ESTUARY - AUGUST 16, 1977

(BROAD CREEK AREA)

Observed Increase in DO:

$$\text{Time} = 0600 - 1200 + \frac{.0020 \ ^{mgO_2}/_{\mu g} \ ^{chloro}/_{hr}}{\text{Time} = 1200 - 1700 + .0075 \ ^{mgO_2}/_{\mu g} \ ^{chloro}/_{hr}}$$

- - - -

TABLE 5

OXYGEN PRODUCTION-RESPIRATION BALANCE

POTOMAC ESTUARY

CHLORO A = 100 µg/l

P = 0.014 MG O_2/µg CHLORO/HR. R = 0.0011 MG O_2/µg CHLORO/HR.

Depth (ft.)	Increase in O_2 Over Water Column Due to Photosynthesis for 12 Hours/Day	Decrease in O_2 Over Water Column Due to Respiration for 24 Hours/Day	Net (mg/l/day)
	Euphotic Zone = 2.0'		
5	6.72	2.64	4.08
10	3.36	2.64	0.72
15	2.24	2.64	-0.40
20	1.68	2.64	-0.96
25	1.34	2.64	-1.30
	Euphotic Zone = 3.0'		
5	10.08	2.64	7.44
10	5.04	2.64	2.40
15	3.36	2.64	0.72
20	2.52	2.64	-0.12
25	2.02	2.64	-0.62
	Euphotic Zone = 4.0'		
5	13.44	2.64	10.80
10	6.72	2.64	4.08
15	4.48	2.64	1.84
20	3.36	2.64	0.72
25	2.68	2.64	0.04

Station	Rate ($gr/m^2/day$)	Remarks
Key Bridge - VA Shore	3.5	Unrepresentative - main channel of river (almost entire width) contained a hard bottom.
Hains Point	2.1	Representative.
Bellevue - VA Side	3.6	Soft, muddy bottom - probably representative.
½ mile below Woodrow Wilson Bridge MD Side	3.1	Soft bottom but unrepresentative - bottom was hard along MD side of shipping channel from Woodrow Wilson Bridge to near Goose Island.
Rosier Bluff - MD Shore	1.4	Hard bottom with clay and gravel - representative.
Fort Washington - Mid River	1.5	Soft bottom - representative.
Dogue Creek - MD Side	5.3	Soft bottom - representative.

7. Two attempts were made to track and monitor a discrete parcel of water in the Upper Potomac Estuary between Rosier Bluff and Piscataway Creek over a semi-diurnal period extending from 0600 hours to about 1700 hours. A floating drogue was used for this purpose. During both occasions (August 16 and 30), tidal conditions, weather conditions, flows, and water temperatures were very similar.

On August 16, the DO concentration (surface) was 1.5 mg/l at 0600 hours and increased to about 5.5 mg/l by 1700 hours. (See Figure 3.) The ambient chlorophyll concentration was 80 ug/l. Computed net rates of oxygen production were 0.0020 mg O_2/ug Chloro/hr between 0600 and 1200 hours and 0.0075 mg O_2/ug Chloro/hr between 1200 and 1700 hours.

POTOMAC ESTUARY DO DATA
ROSIER BLUFF — SWAN CREEK (DPOQUE STUDY)
AUGUST 16, 1977

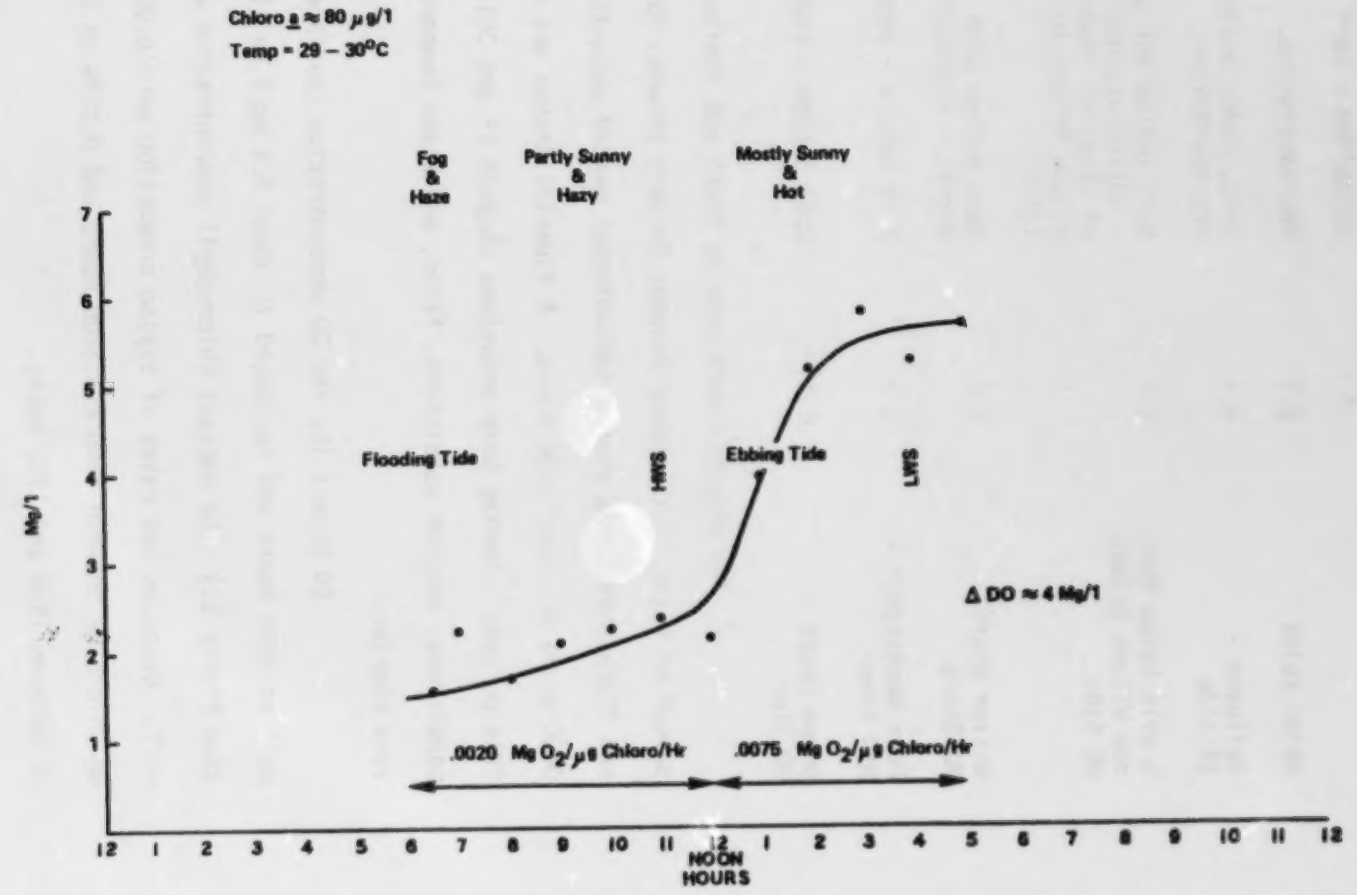


Figure 3

POTOMAC ESTUARY DO DATA
ROSIER BLUFF — PISCATAWAY CREEK (DROGUE STUDY)
AUGUST 30, 1977

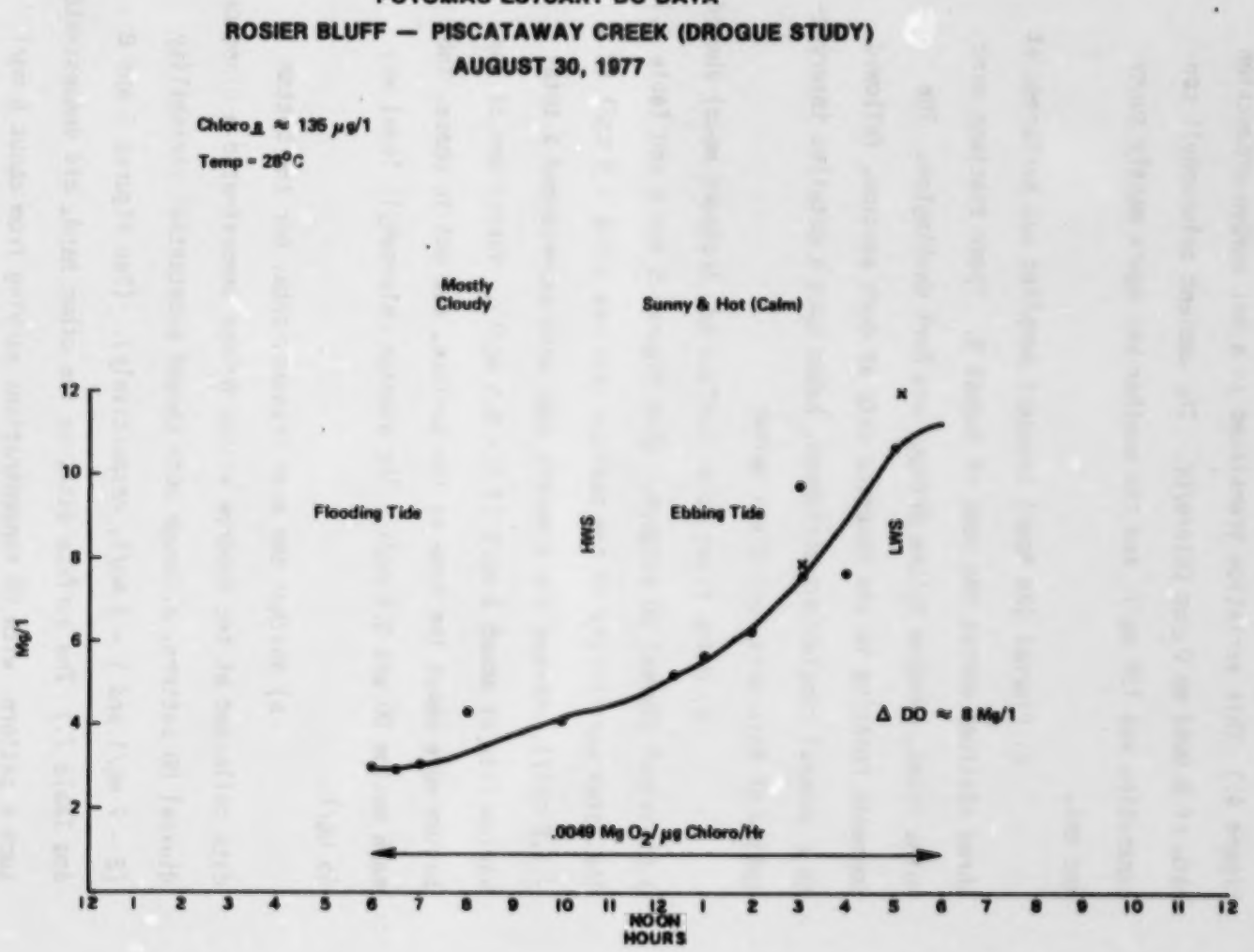


Figure 4

On August 30, the DO concentration (surface) varied from 3.0 mg/l at 0600 hours, to 11 mg/l at 1700 hours. (See Figure 4.) This variation translated to a net oxygen production rate of 0.0049 mg O_2/ug Chloro/hr. The ambient chlorophyll concentration was 135 ug/l, and the weather was again mostly sunny and hot.

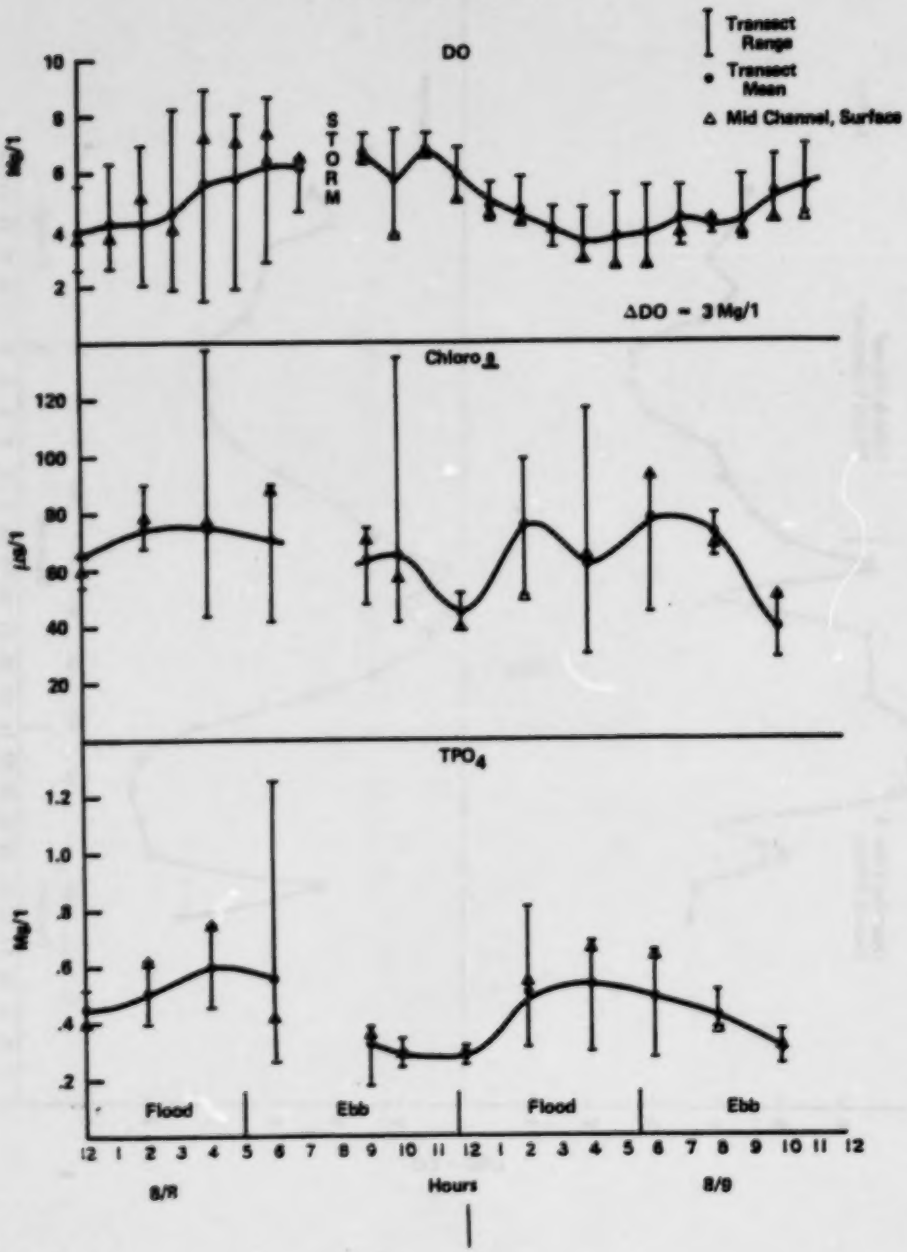
8. Diurnal (24 hour) transect sampling was performed at three stations during the week of August 8. These stations were Hains Point, Woodrow Wilson Bridge, and Fort Washington. The comments relating to the observed data at each station, followed by a general conclusions statement, based upon a detailed interpretation of this data, are given below:

a) Hains Point data (surface and transect mean) showed a classical diurnal DO pattern. (See Figures 5 and 6 and Table 6.) The total variability of the surface data was about 4.5 mg/l (2.5 - 7.0 mg/l), whereas the transect mean data experienced a total variability of about 3 mg/l (3.5 - 6.5 mg/l). Variations at the bottom were about the same as the surface, but not in phase. The mean bottom DO was 3.9 mg/l. The average chlorophyll level was 65 ug/l.

b) Neither the mean transect data, nor the bottom data collected at the Woodrow Wilson Bridge demonstrated a classical diurnal DO pattern, although both showed substantial variability (2 - 7 mg/l and 1 - 4 mg/l, respectively). (See Figures 7 and 8 and Table 7.) The surface data, on the other hand, did demonstrate such a pattern, with DO concentrations varying from about 8 mg/l

Figure 5

DIURNAL TRANSECT DATA
POTOMAC ESTUARY @ HAINS PT.
AUGUST 8-9, 1977



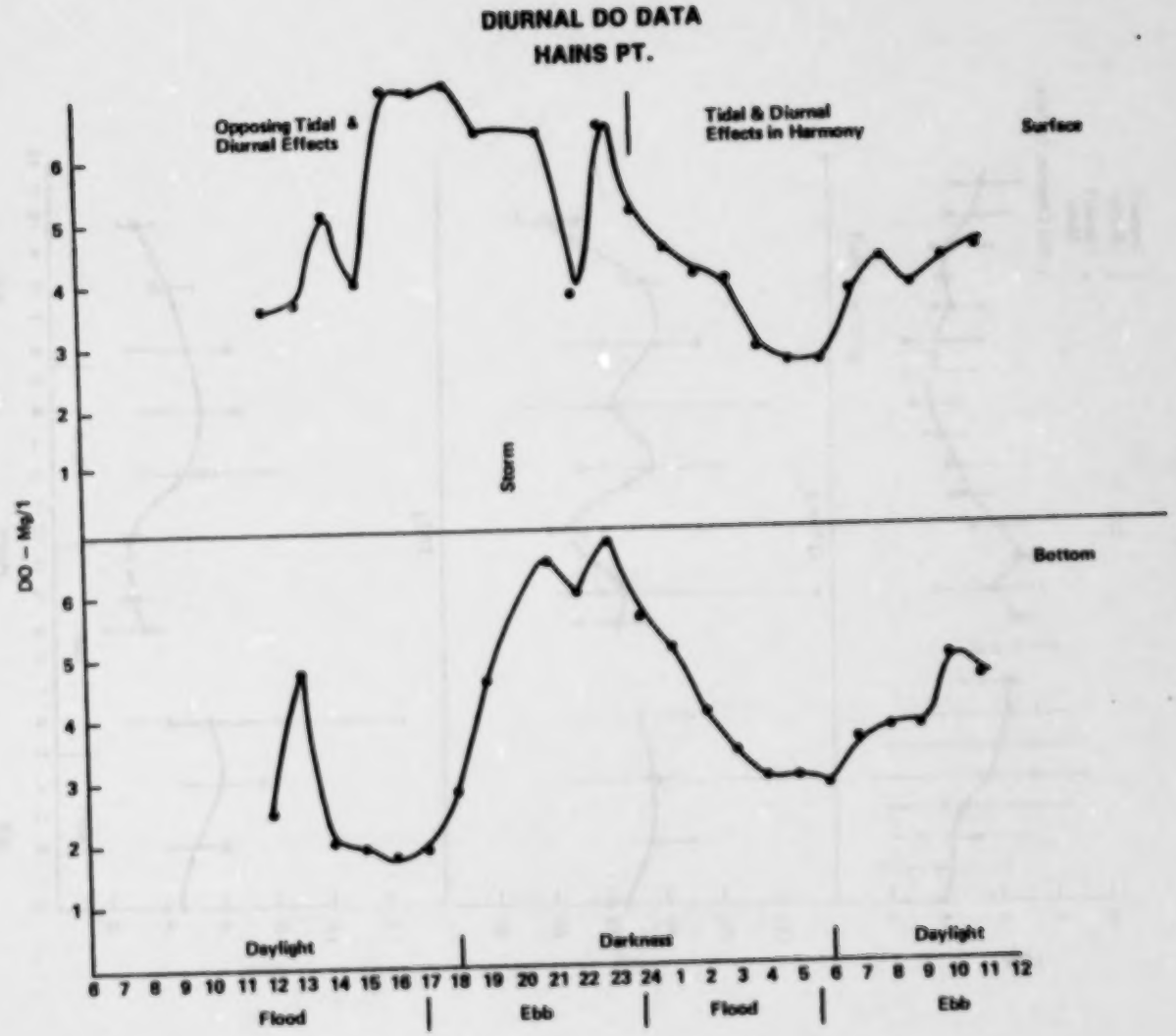

DIURNAL DO DATA
HAINS PT.
Opposing Tidal & Diurnal Effects
Tidal & Diurnal Effects in Harmony
Surface
Storm
Bottom
DO - Mg/l
Daylight
Darkness
Daylight
Flood
Ebb
Flood
Ebb

Figure 6

Table 6

COMPARISON OF SURFACE AND BOTTOM DO

POTOMAC ESTUARY - 1977

HAINS POINT

Date	Time	Chloro (µg/l)	Tide	Surface DO (mg/l)	Bottom DO (mg/l)	Depth (feet)
8/08	1200	60		3.6	2.5	30
	1300		Flood	3.7	4.8	
	1400	80		5.1	2.0	
	1500			4.0	1.9	
	1600	60		7.2	1.5	
	1700			7.1	1.9	
	1800	85		7.3	2.8	
	1900		Ebb	6.4	4.6	
	2100	70		6.4	6.5	
	2200	50		3.8	6.0	
	2300			6.5	6.8	
	2400	45		5.1	5.6	
8/09	0100			4.5	5.1	
	0200	80		4.1	4.0	
	0300		Flood	4.0	3.4	
	0400	65		2.9	3.0	
	0500			2.7	3.0	
	0600	80		2.7	2.9	
	0700			3.8	3.6	
	0800	75		4.3	3.8	
	0900		Ebb	3.9	3.8	
	1000	45		4.3	4.9	
	1100			4.5	4.6	
			ΔDO=	4.5	4.5	
			Avg.	4.7	3.9	

Figure 7

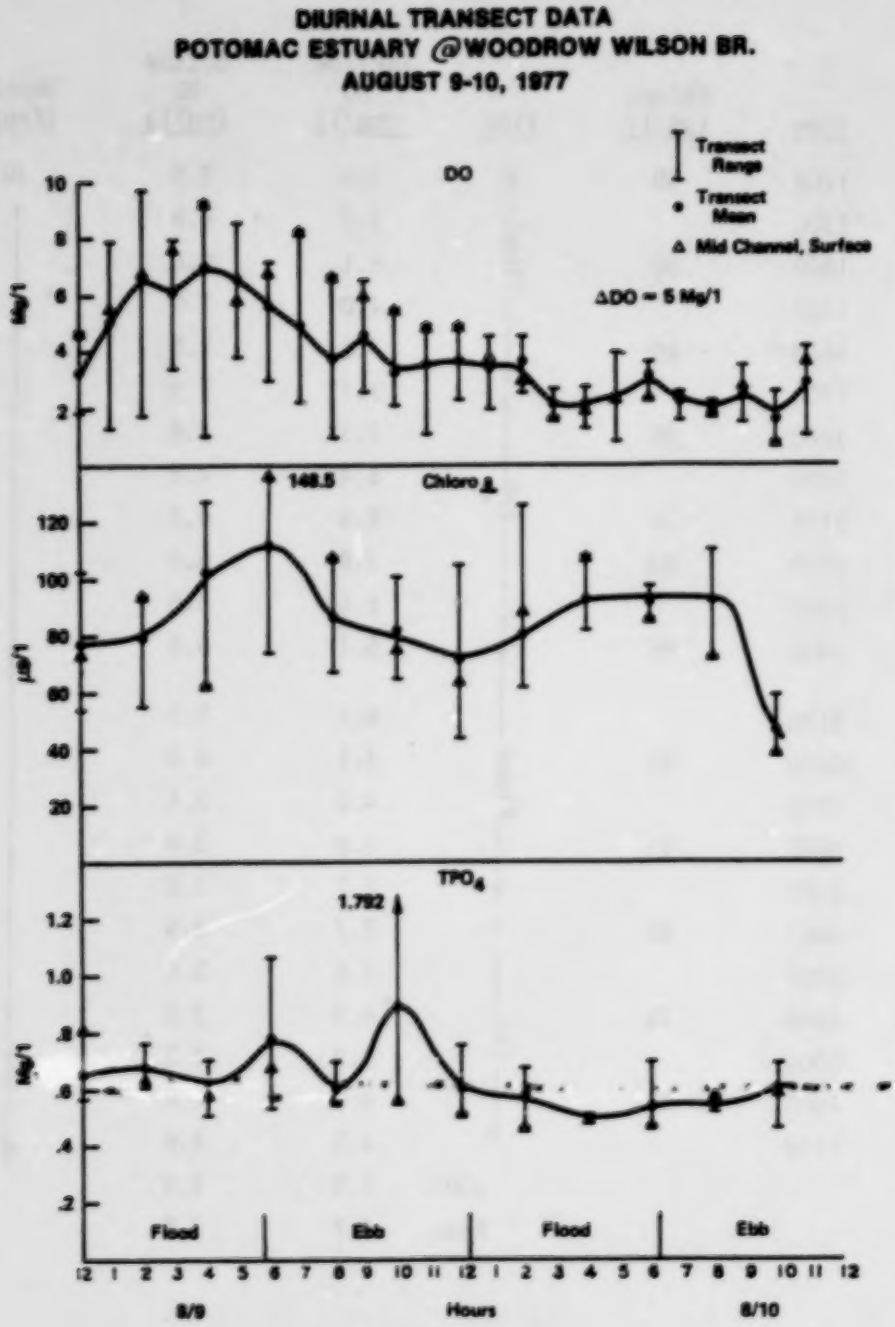

DIURNAL TRANSECT DATA
POTOMAC ESTUARY @WOODROW WILSON BR.
AUGUST 9-10, 1977
DO
Transect Range
Transect Mean
Mid Channel, Surface
ΔDO = 5 Mg/l
Mg/l
148.5
Chloro a
μg/l
TPO4
1.792
Flood
Ebb
Flood
Ebb
8/9
Hours
8/10

Figure 8

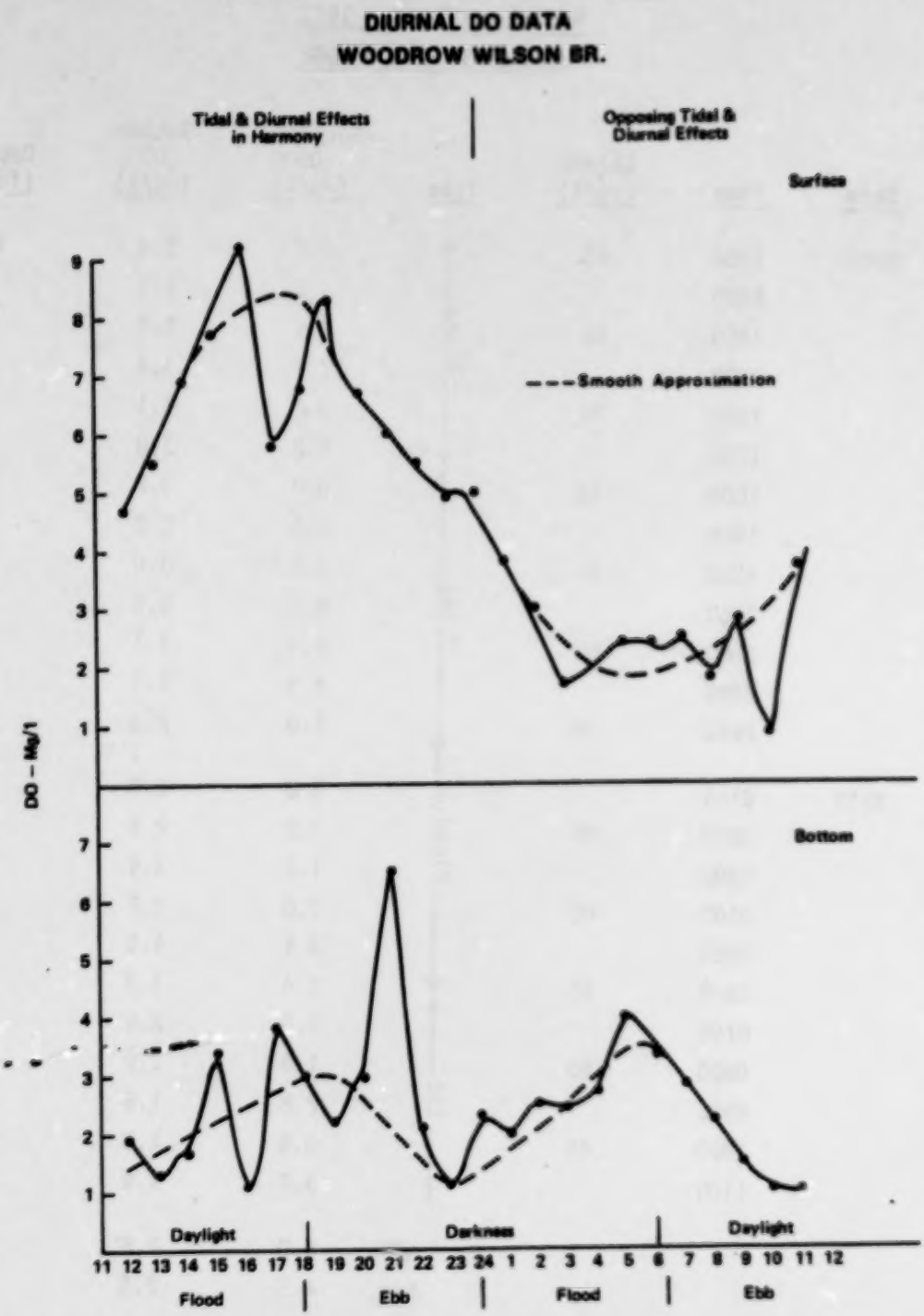

DIURNAL DO DATA
WOODROW WILSON BR.
Tidal & Diurnal Effects in Harmony
Opposing Tidal & Diurnal Effects
Surface
Smooth Approximation
DO - Mg/l
Bottom
Daylight
Darkness
Daylight
11 12 13 14 15 16 17 18 19 20 21 22 23 24 1 2 3 4 5 6 7 8 9 10 11 12
Flood
Ebb
Flood
Ebb

Table 7

COMPARISON OF SURFACE AND BOTTOM DO

POTOMAC ESTUARY - 1977

WOODROW WILSON BRIDGE

Date	Time	Chloro (µg/l)	Tide	Surface DO (mg/l)	Bottom DO (mg/l)	Depth (feet)
8/09	1200	60	↑ Flood	4.7	1.9	15
	1300			5.5	1.3	
	1400	80		6.9	1.7	
	1500			7.7	3.4	
	1600	75	↓	9.2	1.1	
	1700			5.8	3.8	
	1800	130	↑ Ebb	6.8	3.0	
	1900			8.3	2.2	
	2000	90		6.7	3.0	
	2100			6.0	6.5	
	2200	80		5.5	2.1	
	2300			4.9	1.1	
	2400	70	↓	5.0	2.3	
8/10	0100		↑ Flood	3.8	2.0	
	0200	95		3.0	2.5	
	0300			1.7	2.4	
	0400	100		2.0	2.7	
	0500			2.4	4.0	
	0600	90	↓	2.4	3.3	
	0700		↑ Ebb	2.5	2.8	
	0800	80		1.8	2.2	
	0900			2.8	1.5	
	1000	45		0.8	1.0	
	1100		↓	3.7	1.0	
			ΔDO=	6.0	2.5	
			Avg.	4.5	2.5	

Figure 9

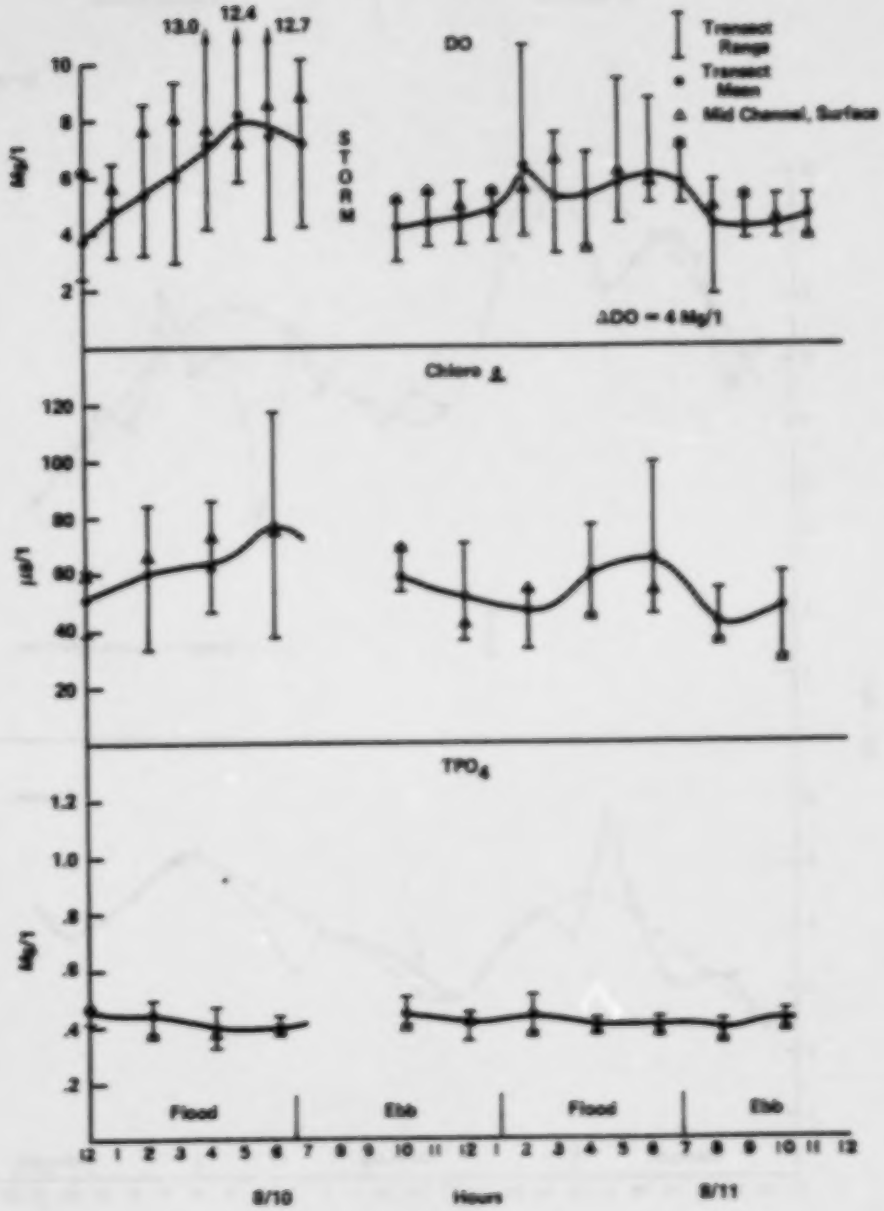

DIURNAL TRANSECT DATA
POTOMAC ESTUARY @ FORT WASHINGTON
AUGUST 10-11, 1977
13.0
12.4
12.7
DO
Transect Range
Transect Mean
Mid Channel, Surface
STORM
mg/l
ΔDO = 4 Mg/l
Chloro a
μg/l
TPO4
Flood
Ebb
Flood
Ebb
8/10
Hours
8/11

Figure 10

DIURNAL DO DATA
FORT WASHINGTON

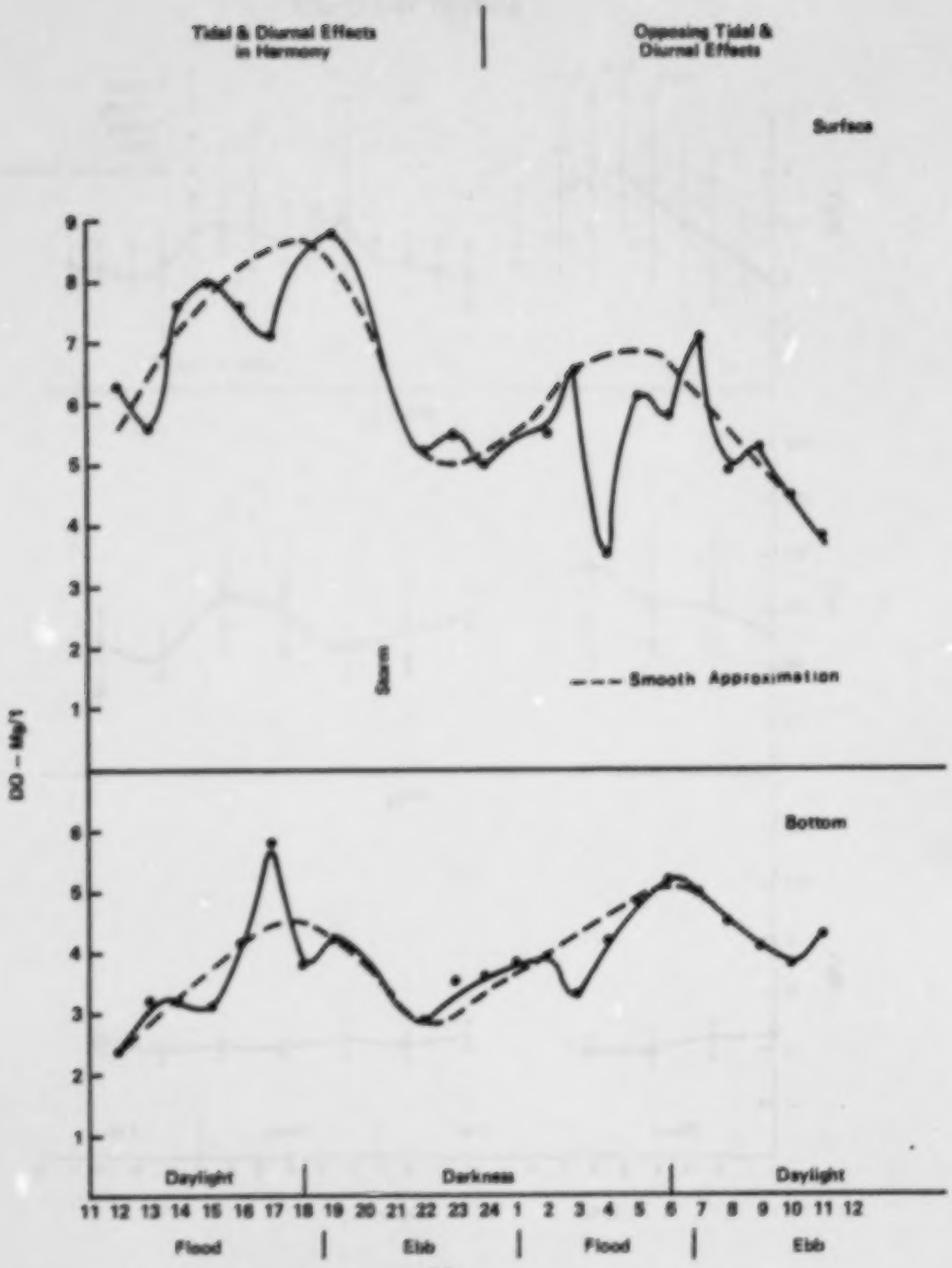


TABLE 8

COMPARISON OF SURFACE AND BOTTOM DO

POTOMAC ESTUARY - 1977

FORT WASHINGTON

Date	Time	Chloro (µg/l)	Tide	Surface DO (mg/l)	Bottom DO (mg/l)	Depth (feet)
8/10	1200	60		6.3	2.4	45
	1300		↑	5.6	3.2	
	1400	45	Flood	7.6	3.2	
	1500			8.0	3.1	
	1600	60		7.6	4.1	
	1700			7.1	5.8	
	1800	70	↓	8.5	3.8	
	1900		↑	8.8	4.2	
	2200	60	Ebb	5.2	2.9	30
	2300			5.5	3.5	45
	2400	55	↓	5.0	3.6	
8/11	0100		↑	5.5	3.8	
	0200	45		5.5	3.9	
	0300		Flood	6.6	3.3	
	0400	60		3.5	4.2	
	0500			6.1	4.8	
	0600	50	↓	5.8	5.2	
	0700		↑	7.1	5.0	
	0800	45		4.9	4.5	
	0900		Ebb	5.3	4.1	
	1000	40		4.5	3.8	
	1100		↓	3.8	4.3	
			BROAD CREEK			
8/30	0600	120		3.1	4.0	20
			ΔDO=	4.0	2.0	
			Avg.	6.0	4.0	

in late afternoon to about 2 mg/l just before dawn. The mean surface DO was 4.5 mg/l, and the mean bottom DO was 2.5 mg/l. The average chlorophyll level was 80 ug/l.

c) In the case of Fort Washington, a classical diurnal DO pattern could not be discerned in the transect mean surface, or bottom data. (See Figures 9 and 10 and Table 8.) The former exhibited a total variability ranging between 4-8 mg/l, and the latter a range from 2.5-5 mg/l. The variability pattern of both the surface and bottom data were quite similar. The mean surface DO was 6.0 mg/l, and the mean bottom DO was 4.0 mg/l. The average chlorophyll level was 55 ug/l.

It is important to recognize that two separate phenomena are the major factors influencing the DO concentrations described above: tidal action, and the algal photosynthesis/respiration cycle; moreover, these processes, at certain times, will work in harmony (i.e. be complementary), while at other times, they will be opposing. An attempt was made to at least discern, if not quantitate, their individual effects. (See Table 9.) Examination of longitudinal DO gradients at the surface during slack water runs, and a comparison of the observed DO variability at both surface and bottom waters (in light of what was considered to be typical tidal variations), leads to the conclusion that at the first two stations (1) algae produce a large diurnal cycle in surface waters which exceeds the local tidally influenced DO variations, and (2) this diurnal cycle is undetectable in bottom waters where the tidal influence alone accounts for practically all of the variability. It can be inferred

TABLE 9

ANALYSIS OF DIURNAL DO DATA

POTOMAC ESTUARY

Station	Chloro (µg/l)	ΔDO (mg/l)	Remarks
Hains Point			
Transect Mean	65	3.0	Algal influenced.
Surface	65	4.5	Algal influenced.
Bottom	65	4.5	Tidal influenced.
Woodrow Wilson Bridge			
Surface	80	6.0	Algal influenced.
Bottom	80	2.5	Tidal influenced.
Fort Washington			
Surface	55	4.0	Algal influenced.
Bottom	55	2.0	Random variation.
Rosier Bluff - Swan Creek			
Surface	80	4.0	Algal influenced.
Rosier Bluff - Piscataway Creek			
Surface	135	8.0	Algal influenced.
Summary	60 - 135	4 - 8	

that the vertical mixing time is of sufficient length to either dampen out the diurnal cycle entirely, or to transmit it out of phase with the surface at a decreased magnitude. At the third station, it appears that tidal action constitutes the dominating force, with respect to diurnal DO fluctuations.

C. Algae

1. Chlorophyll levels were highly variable, both over time and space. Maximum concentrations of about 300 ug/l were recorded during one week in August between Gunston Cove and Indian Head. Average values in the critical reach (between Dogue Creek and Deep Point), were about 150 ug/l, and minimum values were less than 100 ug/l. (See Figure A-2.)

2. Algal mats, floating on the surface of the Potomac Estuary, were never observed during the course of this study, as they were during the late 1960's; however, the greenish tint was present in the high bloom areas extending from about the Woodrow Wilson Bridge to Sandy Point. The indigenous forms of freshwater algae this past summer peared to be almost microscopic in size, and well dispersed in the water column.

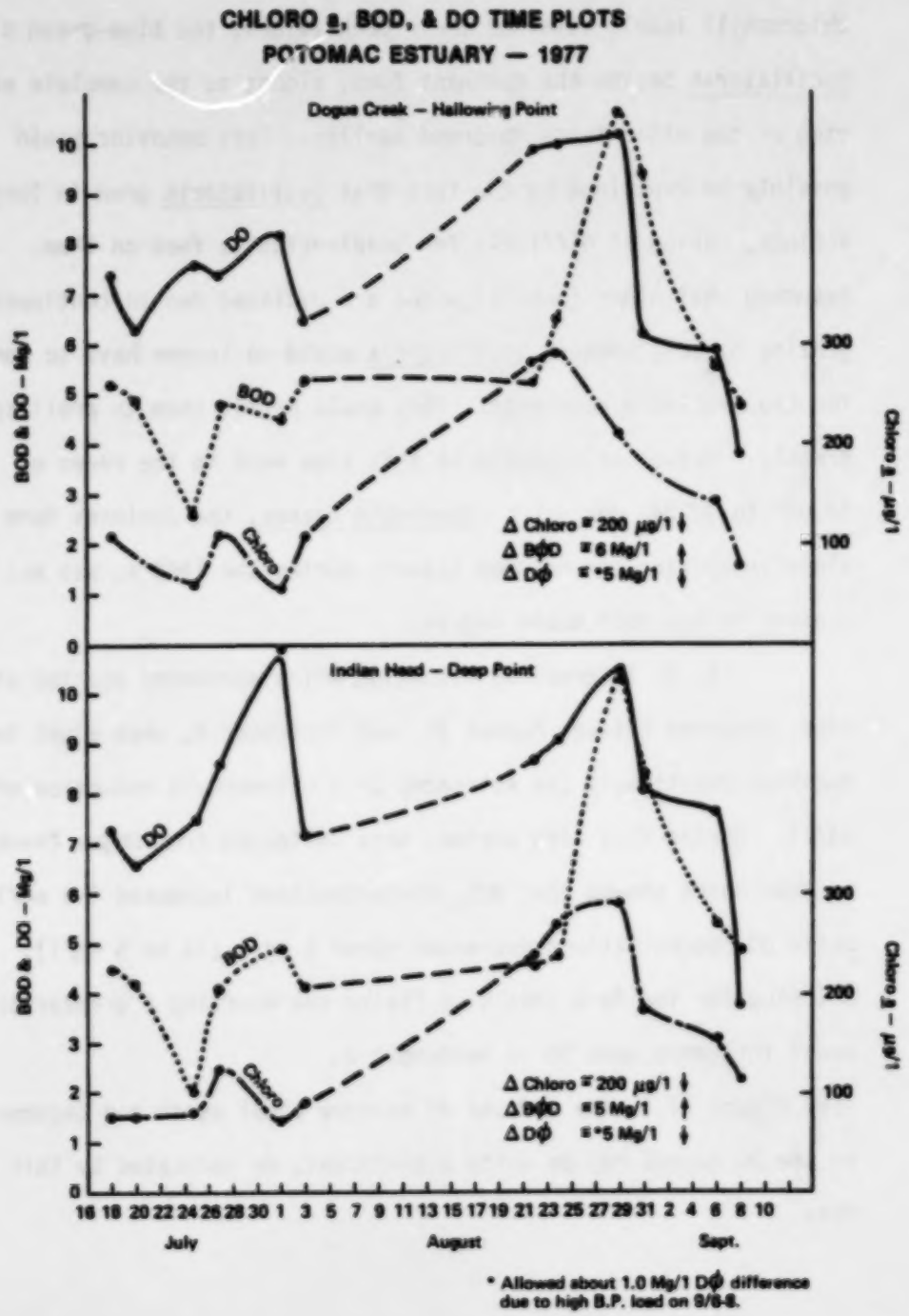
3. A bloom of marine algae, which imparted a "mahogany tide" condition, was observed during the first week of the study in the higher saline waters near the Route 301 Bridge. Chlorophyll levels within the bloom peaked at about 400 ug/l.

4. Phytoplankton counts and species identification were performed. During the early phase of the survey, when chlorophyll levels were about 100 ug/l or less, there appeared to be some

diversity in algal populations, as both green and blue-green varieties were observed; however, as the study progressed, and chlorophyll levels attained their peak values, the blue-green algae Oscillatoria became the dominant form, almost to the complete exclusion of the other forms observed earlier. This behavior could possibly be explained by the fact that Oscillatoria grow in long strings, making it difficult for zooplankton to feed on them. Assuming that other forms of algae are depleted due to continual grazing by zooplankton, Oscillatoria would no longer have to compete for the available nutrients. This would permit them to proliferate greatly. Actual cell counts at this time were in the range of 70,000 to 90,000 per ml. Anacystis cyanea, the dominant form of algae inhabiting the Potomac Estuary during the 1960's, was not present to any noticeable degree.

5. An interesting situation, which warranted special attention, occurred between August 24, and September 8, when algal levels declined drastically (as evidenced by a chlorophyll reduction of 200 ug/l). During this time period, data collected from Dogue Creek to Deep Point showed that BOD_5 concentrations increased 5-6 mg/l, while DO concentrations decreased about 5 mg/l (10 to 5 mg/l), allowing for the fact that Blue Plains was exerting a greater than usual influence upon DO on September 8.
(See Figure 11.) The effects of massive algal death and decomposition on the DO budget may be quite significant, as indicated by this data.

Figure 11


CHLORO a, BOD, & DO TIME PLOTS
POTOMAC ESTUARY — 1977
Dogue Creek – Hallowing Point
Indian Head – Deep Point
DO
BOD
Chloro
BOD & DO – Mg/1
Chloro a – µg/1
Δ Chloro = 200 µg/1
Δ BϕD = 6 Mg/1
Δ Dϕ = *5 Mg/1
Δ BϕD = 5 Mg/1
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.

* Allowed about 1.0 Mg/1 Dϕ difference due to high B.P. load on 9/6-8.

6. Two separate and independent methods were used to estimate a relationship among nitrogen and phosphorus utilization (inorganic forms), algal content of carbon nitrogen and phosphorus (organic forms), and chlorophyll a. One method was based on an analysis of the field data which emphasized spatial differences in nutrient levels, while the other was based on an actual composition analysis of the algal cells in the laboratory. The conclusions drawn were as follows:

a) The mean ratio between organic nitrogen and chlorophyll indicated by the field data was 0.0028 mg N/ug Chloro, with a standard deviation of 0.0008 mg N/ug Chloro. This ratio becomes 0.0056 mg N/ug Chloro if a 50% nitrogen recovery rate is assumed for the analytical procedure followed in the laboratory. The mean ratio between organic phosphorus and chlorophyll, also obtained from field data, was 0.0019 mg PO_4/ug Chloro, with a standard deviation of 0.0004 mg PO_4/ug Chloro. (See Table 10 and Figures 12 and 13.)

b) Compositing selected inorganic nitrogen and phosphorus field data as a function of chlorophyll, yielded typical ratios of 0.01 mg N/ug Chloro, and 0.0011 mg PO_4/ug Chloro, respectively. (See Table 11 and Figures 12 and 13.)

c) Ten different laboratory analyses of the algal cells for elemental composition provided a range of data as shown below:

$$\text{Org C: Chloro} - 0.012 - 0.037 \frac{\text{mg C}}{\text{ug Chloro}}$$
$$\left(\text{average} = 0.028 \frac{\text{mg C}}{\text{ug Chloro}}\right)$$
$$\text{Org N: Chloro} - 0.003 - 0.013 \frac{\text{mg N}}{\text{ug Chloro}}$$
$$\left(\text{average} = 0.007 \frac{\text{mg N}}{\text{ug Chloro}}\right)$$
$$\text{Org P: Chloro} - 0.001 - 0.003 \frac{\text{mg PO}_4}{\text{ug Chloro}}$$
$$\left(\text{average} = 0.002 \frac{\text{mg PO}_4}{\text{ug Chloro}}\right)$$

RELATIONSHIP BETWEEN ORGANIC N & P AND CHLORO A POTOMAC ESTUARY

Date	Station	Chloro (mg/l)	Org * N (mg/l)	Org PO_4 (mg/l)	Mg N* / Mg Chlor	Mg PO_4 / Mg Chlor
7/18	7	147	0.83	.18	.0056	.0012
	8	132	0.44	.16	.0033	.0012
7/20	7	104		.23		.0022
7/25	10	110	0.32	.25	.0029	.0023
7/27	8A	123	0.25	.28	.0020	.0023
	9	118	0.30	.22	.0025	.0019
	10	129	0.28	.25	.0022	.0019
	108	120	0.35	.29	.0029	.0024
	11	112	0.23	.21	.0021	.0019
8/03	6	104	0.29	.27	.0028	.0026
	7	124	0.33	.29	.0027	.0023
	8	104	0.24	.30	.0023	.0029
8/22	5A	130	0.28	.29	.0022	.0022
	6	169	0.41	.29	.0024	.0017
	7	172	0.56	.30	.0033	.0017
	8	276	0.79	.42	.0029	.0015
	8A	306	1.10	.46	.0036	.0015
	9	264	0.89	.44	.0034	.0017
	10	284	0.87	.42	.0031	.0015
	108	198	0.54	.35	.0027	.0018
8/24	6	139	0.27	.30	.0019	.0022
	7	147	0.66	.32	.0045	.0022
	8	261	0.70	.39	.0027	.0015
	8A	306	0.99	.41	.0032	.0013
	9	303	1.09	.50	.0036	.0017
	10	312	1.05	.43	.0034	.0014
	108	228	0.81	.35	.0036	.0015
	11	168	0.57	.30	.0034	.0018
	12	118	0.52	.19	.0044	.0016
8/29	5A	122	----	.25	----	.0020
	6	129	----	.23	----	.0018
	7	152	0.46	.31	.0030	.0020
	8	180	0.61	.30	.0034	.0017
	8A	190	0.74	.41	.0039	.0022
	9	261	0.85	.49	.0033	.0019
	10	300	0.90	.44	.0030	.0015
	108	294	0.77	.50	.0026	.0017
	11	200	0.55	--	.0028	----
	12	158	0.28	.25	.0018	.0016
	13	111	0.24	.21	.0022	.0019
8/31	6	111	0.33	.24	.0030	.0022
	7	134	0.23	.32	.0017	.0024
	8	176	0.40	.37	.0023	.0020
	8A	188	0.40	.37	.0021	.0020
	9	172	0.56	.42	.0033	.0024
	10	195	0.40	.40	.0021	.0021
	108	171	0.62	.33	.0036	.0019
	11	148	0.43	--	.0029	----
9/06	8	104	----	.19		.0018
	8A	146	0.38	.22	.0026	.0015
	9	180	0.45	.30	.0025	.0017
	10	130	0.23	.20	.0018	.0015
	108	180	0.37	.34	.0021	.0019
	11	186	0.30	.33	.0016	.0018
	12	146	----	.28	----	.0019
	13	254	0.25	.30	.0010	.0012
	14	188	----	--	----	----
9/08	10	100	----	.21	----	.0021
	108	130	----	.28	----	.0022
	11	120	----	.24	----	.0020
				Max	.0056	.0029
				Min	.0010	.0012
*Assume 50% recovery				Mean	.0028	.0019
				Std Dev	.0008	.0004

TABLE 11

RELATIONSHIP BETWEEN
INORGANIC N & P AND CHLORO A

POTOMAC ESTUARY

Date	Reach (Stations)	Chloro (mg/l)	ΔN (mg/l)	ΔP (mg/l)
7/20	6-11	90	.9	
	5- 9	90		.10
7/27	7-11	120	1.0	
	5- 8	50		.04
8/01	5-8A	50	.8	.06
	8A-11	70	.8	
8/03	5- 7	50	.5	.06
	7-10B	100	1.0	
8/22	6- 8	100	1.0	
	4- 6	90		.05
	5-10B	180	1.8	
8/24	5-10B	200	1.9	
	4- 7	80		.06
8/29	5A-10B	150	1.6	
	5A- 8	60		.05
8/31	5-10B	100	1.7	
	3- 7	60		.08
9/06	5-11	100	1.7	

Figure 12

NITROGEN — CHLOROPHYLL RELATIONSHIP
POTOMAC ESTUARY — 1977

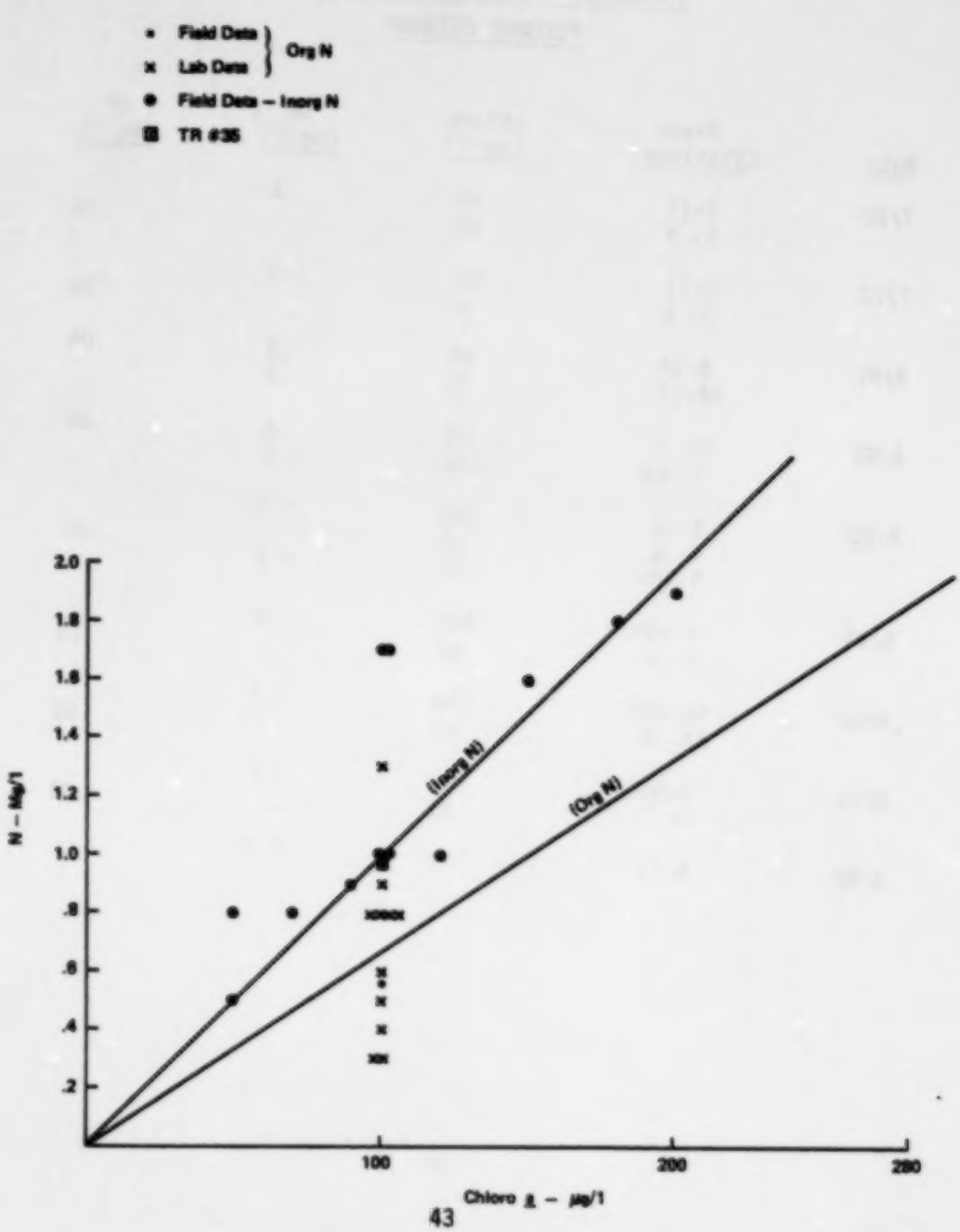
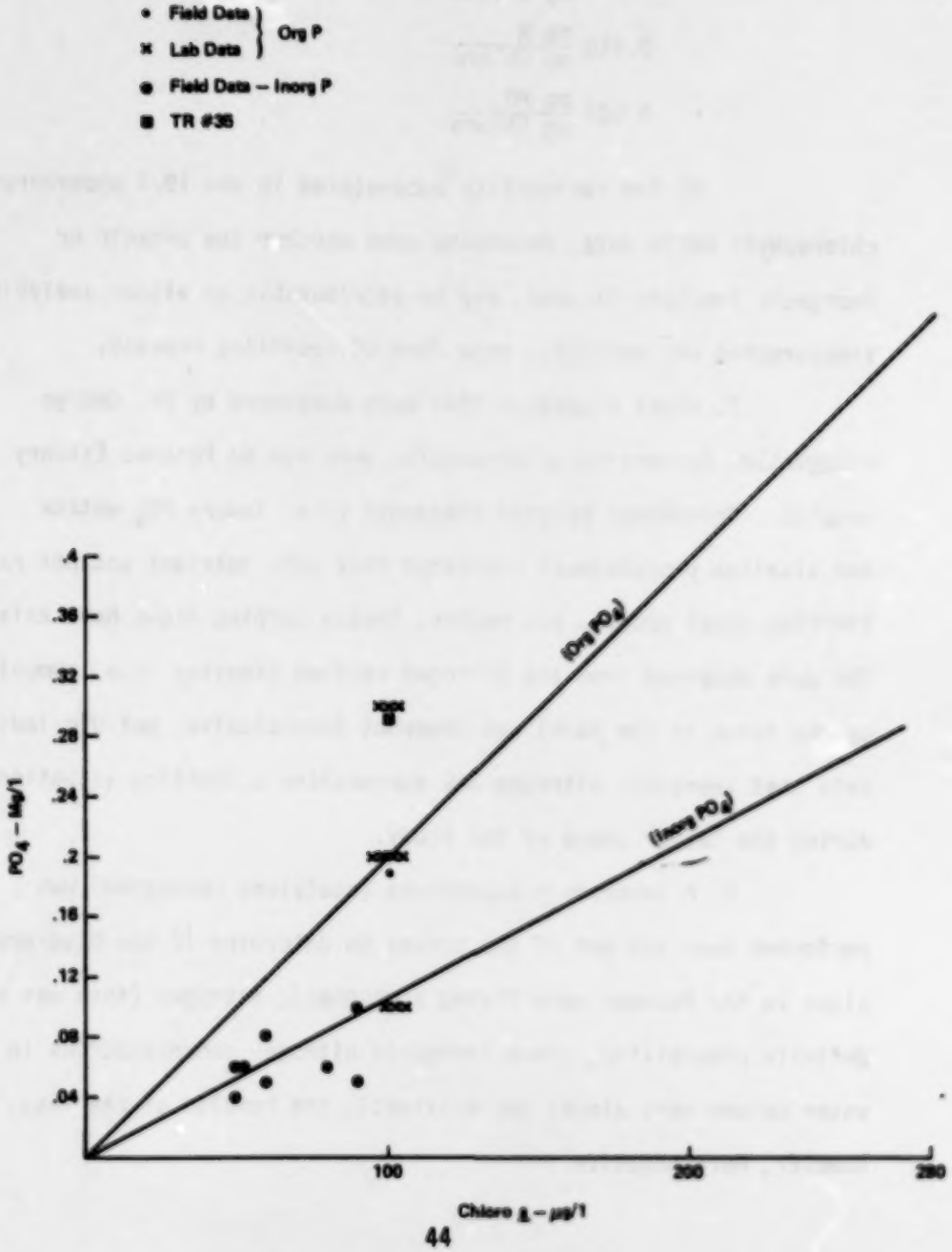


Figure 13

PHOSPHORUS — CHLOROPHYLL RELATIONSHIP
POTOMAC ESTUARY — 1977



For the sake of comparison, the average values of these ratios, which were contained in Technical Report 35 and were based on laboratory findings, are given as follows:

$$0.045 \frac{\text{mg C}}{\text{mg Chloro}}$$

$$0.010 \frac{\text{mg N}}{\text{mg Chloro}}$$

$$0.003 \frac{\text{mg } PO_4}{\text{ug Chloro}}$$

d) The variability encountered in the 1977 phosphorus-chlorophyll ratio data, depending upon whether the organic or inorganic fraction is used, may be attributable to either analytical inaccuracies or, possibly, some form of recycling process.

7. Algal bioassays that were developed by Dr. George Fitzgerald, University of Wisconsin, were run on Potomac Estuary samples. Phosphorus related bioassays (i.e. luxury PO_4 uptake and alkaline phosphatase) indicated that this nutrient was not rate limiting algal growth, but rather, that a surplus might have existed. The data obtained from the nitrogen related bioassay (i.e. ammonium uptake rates in the dark) was somewhat inconclusive, but did indicate that inorganic nitrogen was approaching a limiting situation during the latter phase of the study.

8. A laboratory experiment (acetylene reduction) was performed near the end of the survey to determine if the blue-green algae in the Potomac were fixing atmospheric nitrogen (this was a definite possibility, since inorganic nitrogen concentrations in the water column were almost non-existent); the results of the test, however, were negative.

D. Nutrients

1. Maximum NH_3 concentrations generally varied from about 1.0 to 1.5 mg/l, and invariably occurred in the immediate vicinity of Blue Plains. (See Figure A-3.) The dramatic decrease in NH_3 to virtually undetectable levels, accompanied by a comparable increase in NO_2 + NO_3 over a ten mile stretch of river, indicated that nitrification was proceeding at a rapid rate because of the high ambient temperatures.

2. The NO_2 + NO_3 nitrogen form peaked in the area of maximum nitrification (below Blue Plains) at a level between 1.5 - 2.0 mg/l. (See Figure A-4.) Farther downstream, the concentrations diminished greatly because of algal uptake or other biological utilization.

3. As expected, significant quantities of both soluble and particulate forms of organic nitrogen were present in the Upper Potomac Estuary throughout the study period.

4. Several forms of phosphorus were measured, with the most notable ones being total phosphorus, and filtered inorganic (reactive) phosphorus. With the exception of the September 8 run, TPO_4 concentrations were relatively constant in the estuary downstream of Blue Plains varying between 0.5 and 0.8 mg/l. (The latter figure was obtained when a maximum algal bloom was present.) (See Figure A-5.) The filtered Pi was more variable (0.1 - 0.3 mg/l) on a spatial basis, but did not behave as expected. Instead of diminishing to reflect its utilization by phytoplankton, concentrations generally increased in a downstream direction regardless of

ambient algal bloom conditions. (See Figure A-6.) Data collected by the USGS during a similar time period confirmed this distribution of reactive phosphorus in the Upper Potomac Estuary.

5. Maximum phosphorus concentrations, occurring in the Upper Potomac Estuary near Blue Plains, showed a substantial decrease (>50%) in 1977 over previous years, when levels ranging between 1.5 to 3.0 mg/l were experienced. Inorganic nitrogen, on the other hand, did not exhibit a well defined trend in either direction within this same reach.

6. Concentrations of total inorganic carbon generally varied from about 20-30 mg/l, with no particular spatial or temporal pattern evident. Even when maximum algal levels were encountered, inorganic carbon levels persisted above 20 mg/l, leading one to believe that this nutrient is extremely abundant in the Potomac Estuary and does not have growth rate limiting consequences.

7. An analysis of the spatial distribution of nutrients and chlorophyll (i.e. phytoplankton densities) in the Potomac Estuary, indicates that the inorganic nitrogen may be limiting algal growth in the area of maximum production (downstream of Hallowing Point), since concentrations of both NH_3 amd NO_3 become non-detectable as bloom conditions progress. It is suspected that light may be the limiting factor in the upper zone (i.e. upstream of Piscataway Creek), where considerably lower chlorophyll levels are normally found.

8. There is no indication, based on the observed water quality monitoring data, that phosphorus is a rate limiting nutrient

at the present time. The fact that inorganic (soluble) phosphorus concentrations actually experienced an increase in areas of algal bloom production indicates that recycling/regeneration or possible recruitment from the benthos may be important reactions which should be further investigated.

E. BOD

1. Maximum BOD_5 concentrations in the vicinity of Blue Plains ranged from about 8-12 mg/l. A BOD_5 of 10 mg/l was also measured in the area of a peak algae bloom on August 29. (See Figure A-7.)

2. Long term (e.g. 20 days) inhibited and non-inhibited BOD analyses were performed on many of the river samples in order to approximate the first order decay or oxidation rates for both the carbonaceous and nitrogenous components. The mean rates provided by this study are as follows:

CBOD - 0.14/day (base e - 20°C) (Std. Dev. = 0.023)

NBOD - 0.14/day (base e - 20°C) (Std. Dev. = 0.053)

3. The CBOD rates were also estimated for the major load inputs to the estuary. The average value for the wastewater effluents was 0.17/day (base e - 20°C), and that for the Chain Bridge station was 0.13/day (base e - 20°C). The standard deviations were 0.046 and 0.026, respectively.

4. A sizeable percentage of the BOD_5 measurement for the wastewater effluents was attributable to the nitrification reaction. Consequently, the ratios of $CBOD_{ult}/BOD_5$, and $CBOD_{ult}/CBOD_5$ were significantly different. The results of this special long term

rate study indicated these ratios to be 1.30 and 1.75, respectively.

F. Estuary Loadings

1. Blue Plains is by far the largest single point source discharger of oxygen demanding material and nutrients in the Potomac Estuary. (See Table 12) During the study period, it contributed an average flow of 276 mgd, and the following average loadings:

Parameter	Average Loading	% of Total Point Source Wastewater Load
BOD_5	58,000 lbs/day*	78*
TKN	36,500 lbs/day	75
NH_3	32,500 lbs/day	76
$NO_2 + NO_3$	250 lbs/day	14
TPO_4	12,200 lbs/day	55

2. For comparison, the average pollutant loadings from Blue Plains in 1970, based on an average flow of 252 mgd, were estimated to be as follows:

Parameter	Average Loading	% of Total Point Source Wastewater Load
BOD_5	104,000 lbs/day	75
TKN	46,200 lbs/day	85
$NO_2 + NO_3$	2,000 lbs/day	55
TPO_4	52,000 lbs/day	75

3. The non-tidal portion of the Potomac River continues to be a significant contributor of BOD and certain nutrients to the estuary. This is demonstrated by the relatively high average

*On September 8, 1977, a mechanical breakdown occurred at the Blue Plains treatment plant, causing a BOD_5 loading of 344,000 lbs/day. If this loading were included in the analysis, the average BOD_5 load would be 82,000 lbs/day, which constitutes 85% of the total point source BOD_5 load generated by the Washington Metropolitan Area.

TABLE 12

SUMMARY OF SEWAGE TREATMENT PLANT EFFLUENT DATA

1977 POTOMAC INTENSIVE

		Piscataway	Arlington	Blue Plains	Alexandria	Westgate	Hunting Creek	Dogue Creek	Pohick Creek
Flow (mgd)	Mean	11.91	19.56	276.40	19.39	10.770	4.09	2.26	14.02
	Min.	7.50	17.80	251.00	18.77	10.400	3.75	2.09	13.46
	Max.	16.00	21.00	313.00	20.18	11.630	4.48	2.63	14.75
TC (mg/l)	Mean	43.97	69.63	83.50	105.34	85.570	32.50	30.65	85.35
	Min.	29.15	63.83	73.20	70.56	40.630	27.91	24.28	58.40
	Max.	87.03	85.48	131.37	141.53	97.710	39.70	37.98	101.49
TOC (mg/l)	Mean	12.66	18.82	33.62	52.02	25.500	12.97	14.41	28.00
	Min.	6.72	9.11	19.11	11.15	10.190	6.65	9.37	11.33
	Max.	28.37	42.44	96.37	103.31	58.860	17.23	19.55	55.89
TP (mg/l)	Mean	2.98	15.20	5.30	19.71	13.820	.83	.89	22.35
	Min.	1.96	12.18	4.11	17.00	11.000	.48	.72	20.20
	Max.	5.00	17.02	8.00	23.22	15.080	1.09	1.45	23.52
PI (mg/l)	Mean	2.36	13.56	3.74	16.52	12.790	.23	.19	19.64
	Min.	1.72	11.96	2.99	13.00	9.900	.12	.09	18.40
	Max.	4.07	15.20	6.00	19.26	14.520	.36	.34	21.56
TKN (mg/l)	Mean	6.00	14.88	15.88	20.28	18.890	21.11	21.78	21.81
	Min.	4.01	7.39	14.47	17.94	16.970	18.51	16.08	10.61
	Max.	12.90	21.60	17.89	21.90	22.350	24.21	34.42	30.53
$NO_2 + NO_3$ (mg/l)	Mean	4.73	4.26	.11	.10	.025	1.88	1.50	1.87
	Min.	1.74	1.57	ND	ND	ND	1.52	.97	.07
	Max.	6.77	9.29	.68	.26	.050	2.28	2.21	8.24
NH_3 (mg/l)	Mean	4.53	13.59	14.09	18.55	16.000	19.69	19.92	19.18
	Min.	2.33	6.90	11.60	15.60	5.600	17.10	17.60	6.02
	Max.	12.90	21.60	16.70	20.60	19.800	23.10	29.30	24.20
BOD_5 (mg/l)	Mean	6.57	8.79	34.28	49.30	12.700	13.10	11.10	15.78
	Min.	0	1.20	3.20	9.30	2.900	2.80	4.20	3.00
	Max.	17.40	15.60	132.00	70.30	19.200	18.30	27.60	23.70
BOD_{20} (mg/l)	Mean								
	Min.								
	Max.								
Turbidity	Mean	4.13	6.27	15.54	25.10	7.800	6.98	9.55	8.93
	Min.	2.50	2.50	8.00	20.00	4.750	4.00	5.50	4.00
	Max.	6.50	10.00	25.50	30.00	12.000	15.00	19.00	12.00

concentrations of these pollutants measured at the Chain Bridge station during the study period, as shown in the table below:

Parameter	Average Concentration (mg/l)	Standard Deviation (mg/l)	Average Loading (lbs/day)
BOD_5	2.58	.77	2,358
DO	7.41	.46	-----
TKN	.49	.10	444
Org.-N	.46	.10	415
NH_3	.03	.03	29
$NO_2 + NO_3$	.03	.04	25
TPO_4	.25	.04	230
Inorg. PO_4	.04	.05	40
Filt. Inorg. PO_4	.02	.02	-----
TC	32.28	2.60	28,533
TOC	5.43	3.30	4,693
Chlorophyll a	42.88*	23.20*	41

4. Storm sewer and combined sewer contributions from the WMA were estimated (order of magnitude type) based upon the best available information. These loads, along with the two other major loads to the Potomac Estuary (point source and upper basin inputs), were translated to a total poundage for the study period and are summarized and compared in the following table:

*ug/l

Parameter	Input Category		
	Point Source	Upper Basin	Urban
Flow Volume (ft^3)	2.4×10^9	6.5×10^9	2.2×10^9
BOD_5 (lbs)	3.7×10^6	1.0×10^6	2.0×10^6
Total N (lbs)	0.8×10^6	0.1×10^6	0.3×10^6
Total PO_4 (lbs)	1.1×10^6	0.1×10^6	0.5×10^6

5. On September 8, the last day of the survey, Blue Plains was discharging a very poor quality effluent, as evidenced by a BOD_5 concentration of 132 mg/l (344,160 lbs/day, loading). This BOD_5 has since been refuted by Blue Plains personnel, but USGS field staff sampling the Potomac has corroborated the fact that on this date, the effluent from Blue Plains was very poor. Its impact on the receiving water quality was considerable. The BOD concentrations in the estuary near Blue Plains exceeded 11.0 mg/l on September 8, the highest value recorded during the survey. More importantly, the DO concentrations on this date ranged between 1.8 and 4.0 mg/l over a 20 mile stretch of estuary from Bellevue to Indian Head. Other water quality parameters, such as nutrients, were also elevated during the September 8 run.

G. Herbicides

1. Special analyses for the herbicides atrazine and simazine were performed on samples collected at approximately every other station in the Potomac Estuary on July 18, and August 22. These are widely used herbicides on corn crops, which have been identified in other areas of the Chesapeake Bay.

a) On July 18, a day following a rainfall event of 0.25 inches, maximum concentrations of both atrazine and simazine occurred between the Woodrow Wilson Bridge and Dogue Creek. The levels varied from .84 - 1.15 ug/l and .49 - .78 ug/l, respectively. The incoming concentrations at Chain Bridge were .46 ug/l and .34 ug/l, respectively.

b) On August 22, following an extended dry period, atrazine and simazine concentrations were considerably lower in the estuary: 0.4 - 0.5 ug/l, and 0.3 - 0.4 ug/l, respectively. Again, maximum levels were recorded in the upper portion of the estuary near and below Washington. Concentrations at Chain Bridge did not change radically with atrazine being 0.38 ug/l and simazine, 0.33 ug/l.

c) Atrazine and simazine were also monitored in the effluents of the major sewage treatment plants and at Chain Bridge on July 11. The results are shown in the table below:

Location	Atrazine (ug/l)	Simazine (ug/l)
Piscataway STP	.75	.38
Arlington STP	1.21	.54
Blue Plains STP	1.72	.55
Alexandria STP	1.08	.52
Westgate STP	.26	.28
Hunting Creek STP	.70	.10
Dogue Creek STP	1.06	.19
Pohick Creek STP	1.39	.52
Chain Bridge	.92	.49

The comparatively high values recorded at Chain Bridge may have been due to a 0.43 inch rainfall which occurred on July 9. The reason for the even higher values at most of the sewage treatment plants has not been adequately determined.

CHAPTER IV

FUTURE STUDY NEEDS

In addition to a continued ambient monitoring program in the Potomac, forthcoming intensive studies to be conducted by AFO will include the following elements to rectify present data gaps:

a) Expanded drogue studies to include 24 hour sampling at both surface and bottom.

b) Improved delineation of the BOD load to include not only the carbonacenous and nitrogenous components, but the algal components as well.

c) Use of a photometer/transmissometer to better define the euphotic zone in the Upper Potomac Estuary.

d) Further SOD studies to extend the area of coverage and to obtain a better resolution of the data.

Another future study need concerns an improved definition of the phosphorus budget and the role of suspended sediment as a contributor of and a transport media for different forms of phosphorus. Other reactions which should be considered and investigated in more detail as part of the phosphorus budget include recycling and remineralization, both within the water column as well as at the water sediment interface. This study, however, is presently beyond the capabilities of AFO.

APPENDIX

Figure A-1

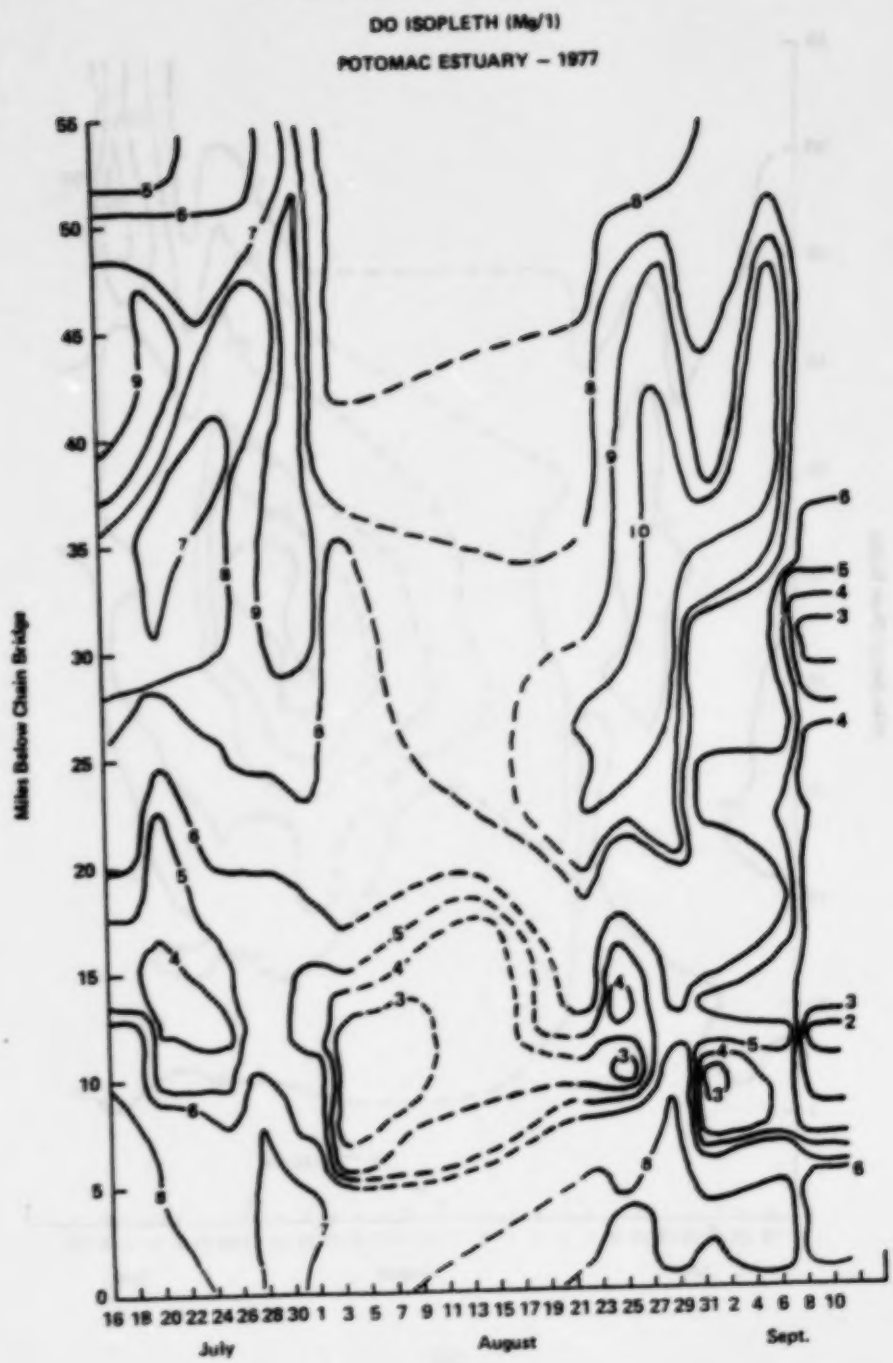

DO ISOPLETH (Mg/1)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.

Figure A-2

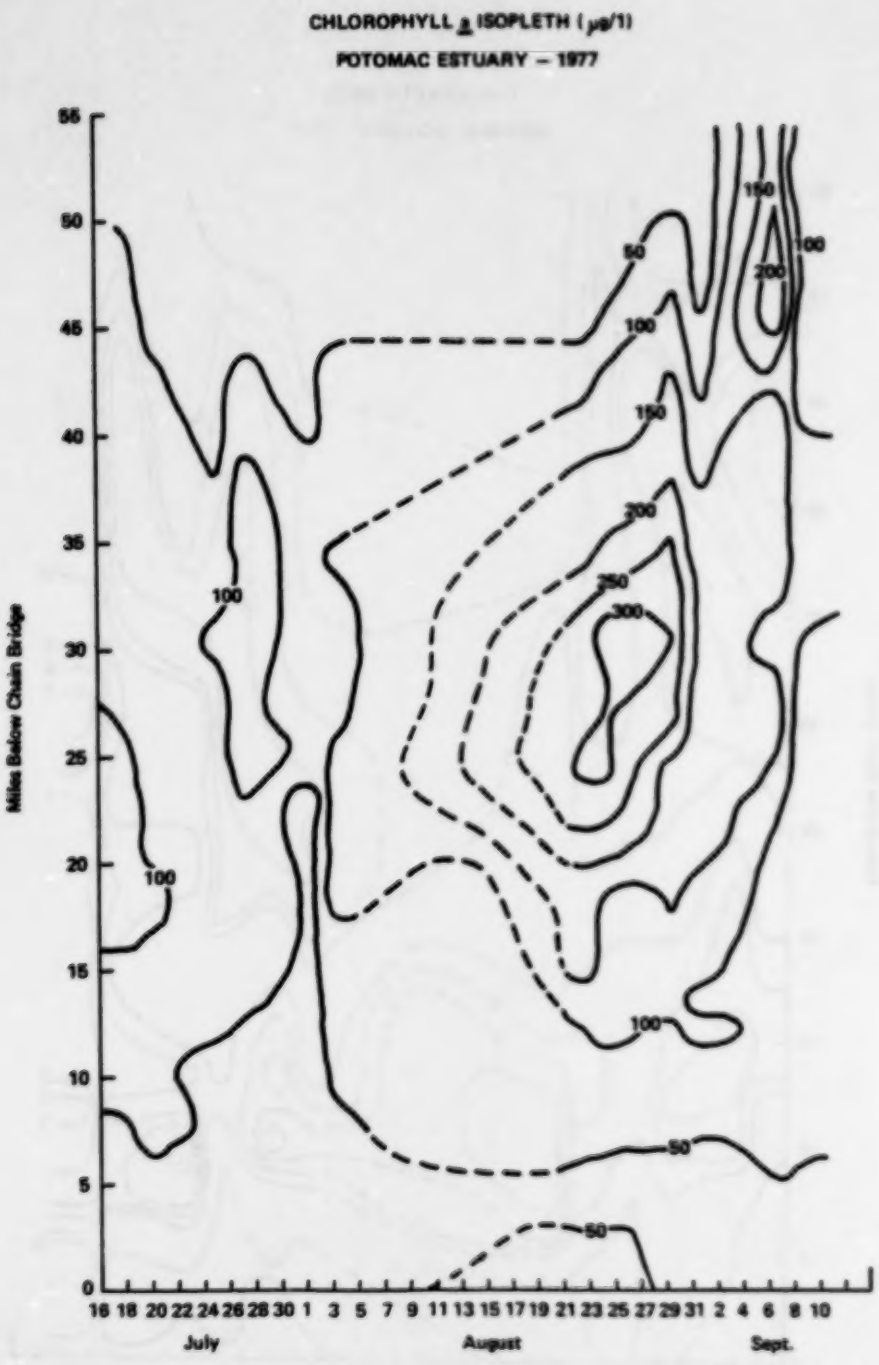

CHLOROPHYLL a ISOPLETH (μg/l)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
50
100
150
200
250
300
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.

Figure A-3

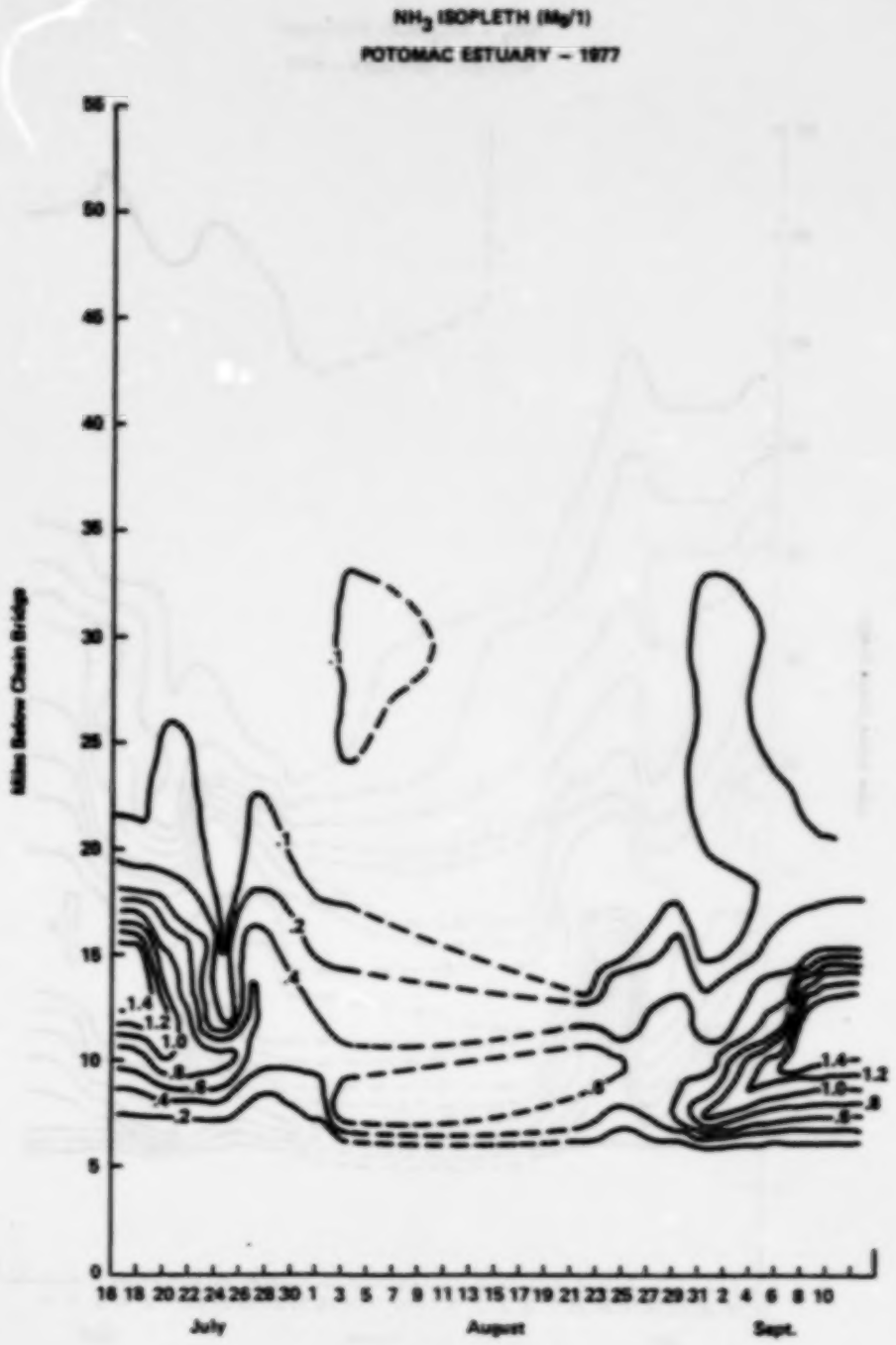

NH_3 ISOPLETH (Mg/1)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
.1
.2
.4
.6
.8
1.0
1.2
1.4
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.

Figure A-4

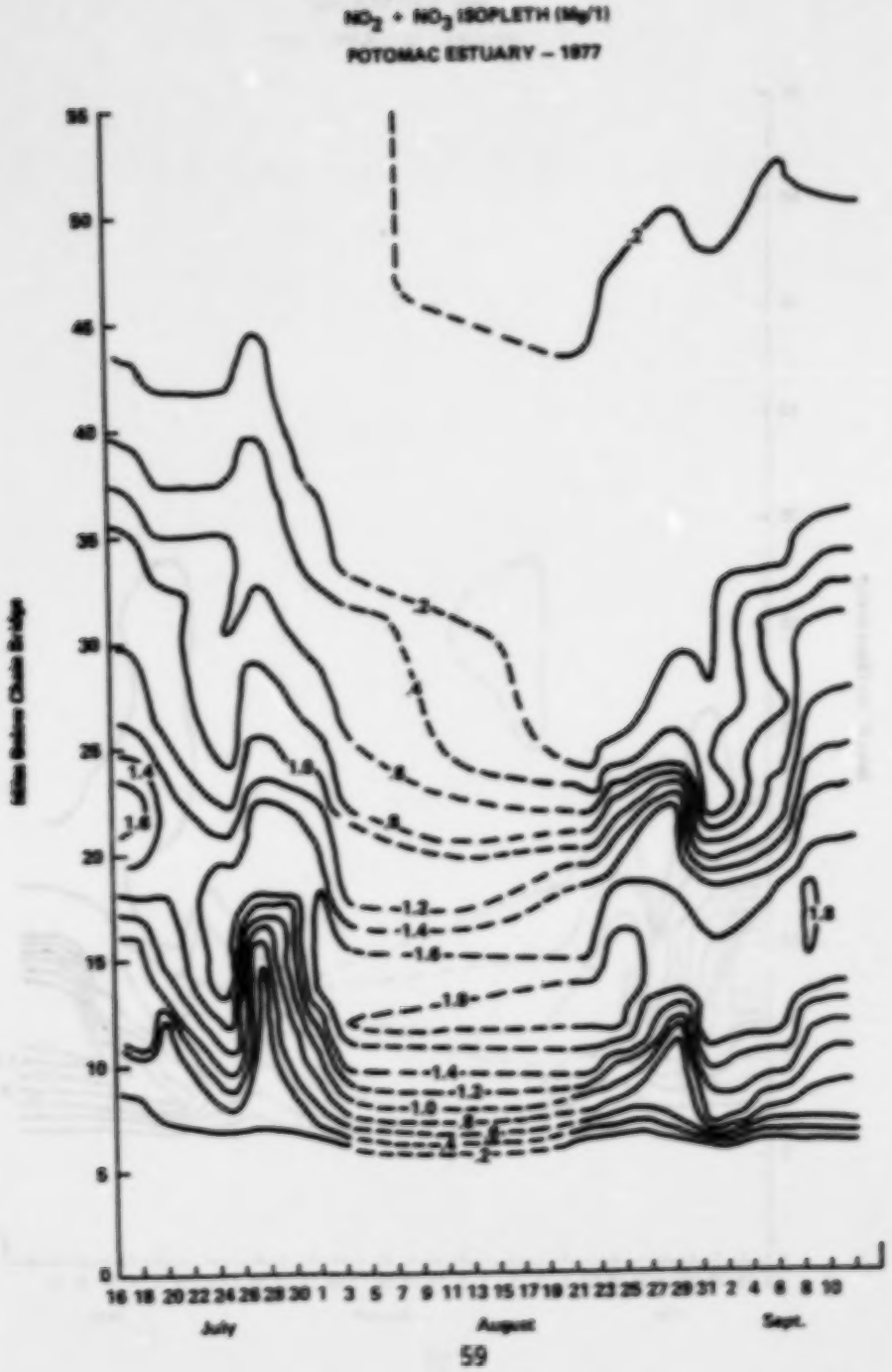

NO_2 + NO_3 ISOPLETH (Mg/l)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.

Figure A-5

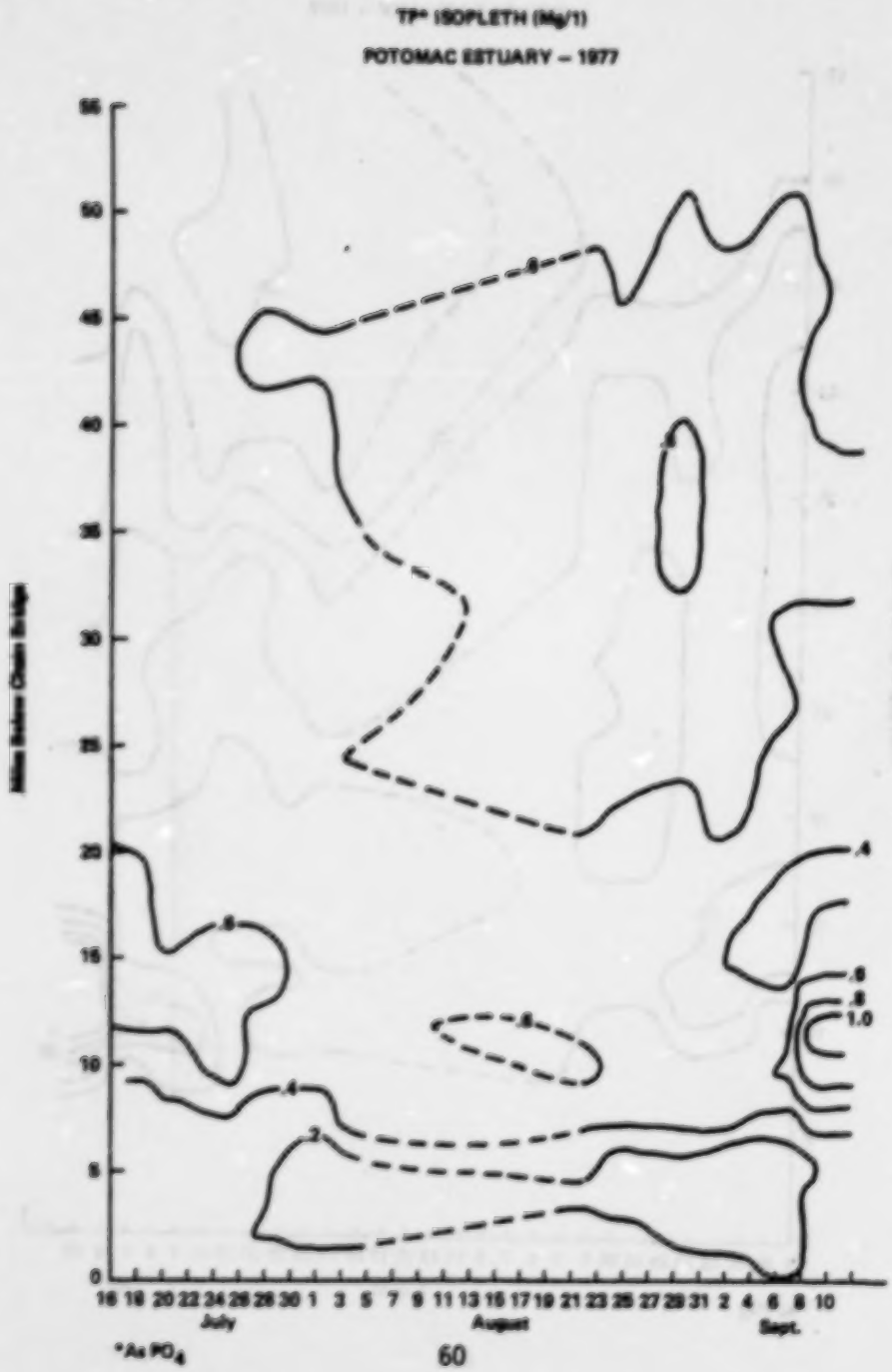

TP* ISOPLETH (Mg/1)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
.8
.4
.2
.6
.8
1.0
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.
*As PO_4

Figure A-6

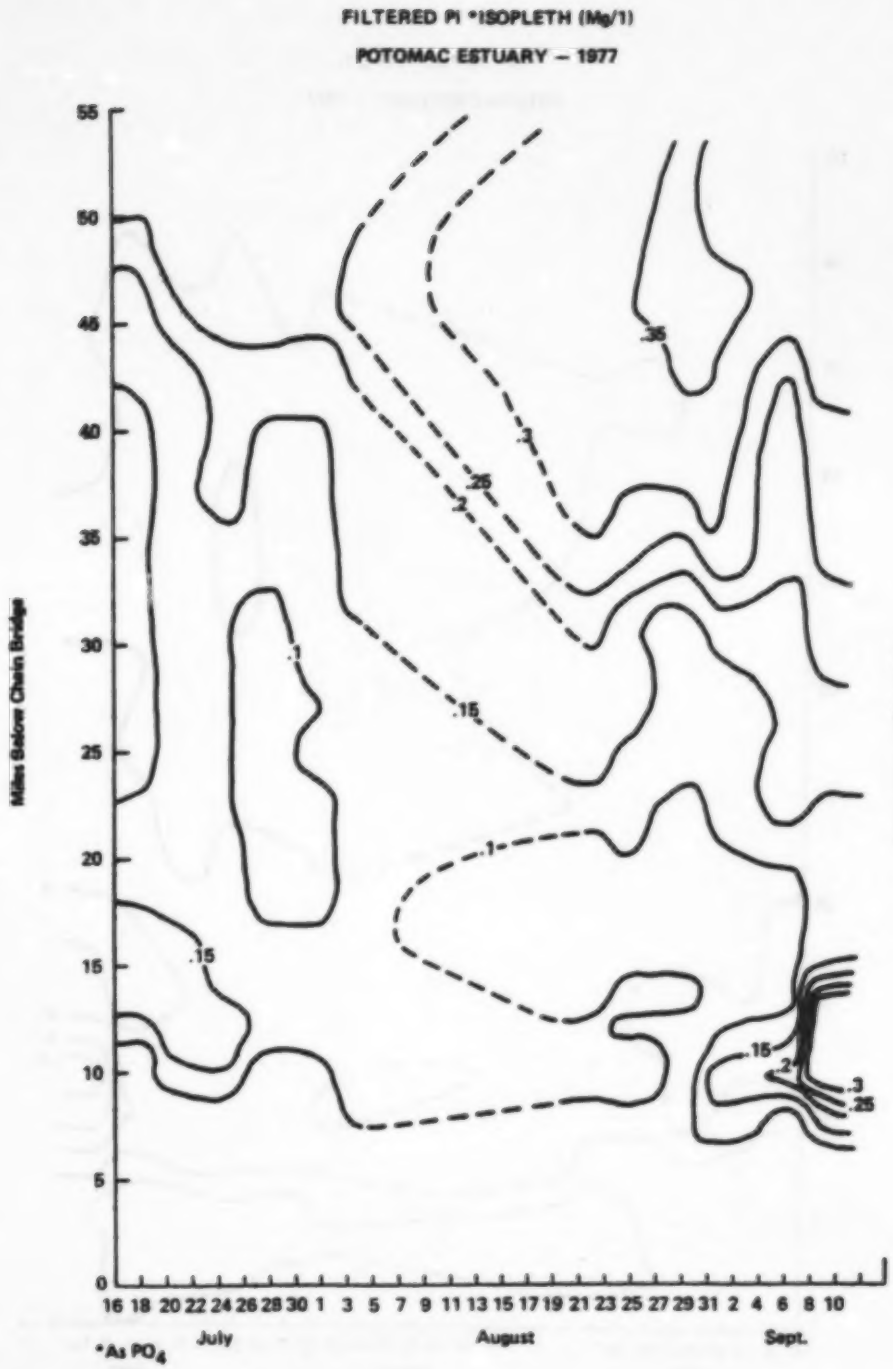
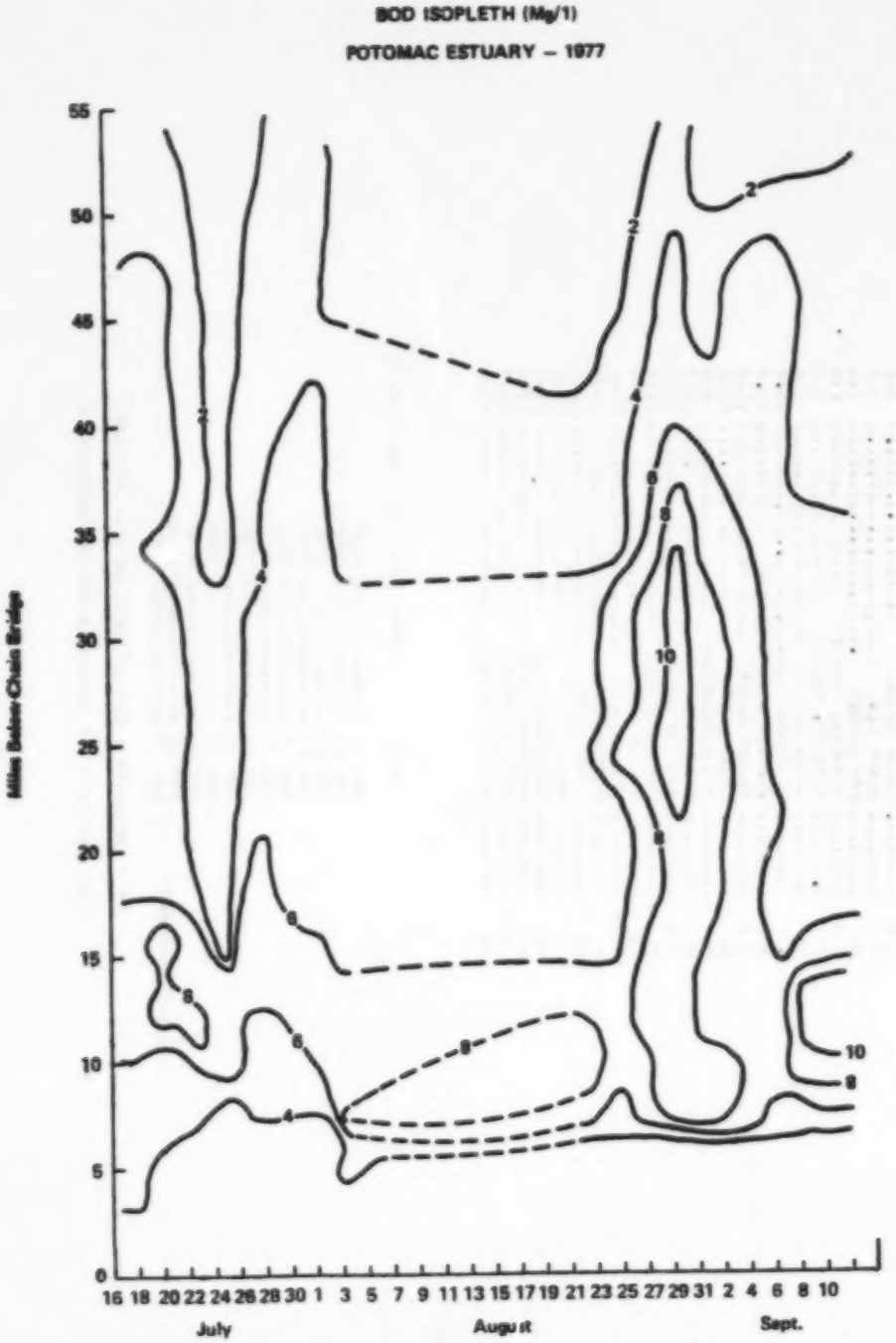

FILTERED PI *ISOPLETH (Mg/1)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
.35
.3
.25
.2
.1
.15
.1
.15
.15
.2
.3
.25
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.
*As PO_4

Figure A-7


BOD ISOPLETH (Mg/1)
POTOMAC ESTUARY – 1977
Miles Below Chain Bridge
55
50
45
40
35
30
25
20
15
10
5
0
16 18 20 22 24 26 28 30 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 2 4 6 8 10
July
August
Sept.
2
4
6
8
10

SAMPLING STATION LOCATIONS

STATION	LOCATION	RMI (=MILES BELOW CHAIN BRIDGE)
P-8	CHAIN BRIDGE	0.0
P-4	WINDY RUN	1.9
1	KEY BRIDGE	3.4
1-A	MEMORIAL BRIDGE	4.9
2	14TH ST. BRIDGE	5.9
3	HAINS POINT	7.6
4	BELLEVUE	10.0
5	WOODROW WILSON BRIDGE	12.1
5-A	ROSIER BLUFF	13.6
6	BROAD CREEK	15.2
7	FT. WASHINGTON	18.4
8	DOGUE CREEK	22.3
8-A	GUNSTON COVE	24.3
9	CHAPMAN POINT	26.9
10	INDIAN HEAD	30.6
10-A	DEEP POINT	34.0
11	POSSUM POINT	38.0
12	SANDY POINT	42.5
13	SMITH POINT	45.8
14	MARYLAND POINT	52.4
15	NANJEMOY CREEK	58.6
15-A	MATHIAS POINT	62.8
16	RT. 301 BRIDGE	67.4

DATE	FLOW AT LITTLE FALLS (CFS)
JUL 18	2100
JUL 20	1690
JUL 25	2770
JUL 27	1970
AUG 1	1640
AUG 3	1320
AUG 22	1780
AUG 24	2570
AUG 29	999
AUG 31	1030
SEP 6	1050
SEP 8	1110

**** INDICATES A LAB ACCIDENT OR TEST NOT DONE

0.0 INDICATES THE PARAMETER WAS NON-DETECTABLE

TABLE A-1

Summary of 1977 Potomac Estuary Data

****

POTOMAC RIVER DATA FOR JULY 18, 1977

****

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	P(CF) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-R	26.0	0.0	****	****	9.20	0.40	0.05	0.0	0.32	0.08	0.0	29.36	8.77	31.5	7.50	6.73
P-4	30.6	0.0	****	24.0	8.50	0.50	0.0	0.0	0.29	0.07	0.0	27.99	7.95	39.0	5.40	7.87
1	30.6	0.0	****	24.0	8.00	0.55	0.0	0.0	0.28	0.07	0.0	29.27	7.85	40.5	6.20	6.97
1-A	30.7	0.0	****	24.0	7.50	0.51	0.0	0.0	0.26	0.07	0.0	27.72	7.60	42.0	6.30	6.71
2	30.7	0.0	****	24.0	6.80	0.48	0.0	0.0	0.25	0.07	0.0	27.63	7.51	42.0	6.60	8.22
3	30.7	0.0	****	19.0	15.00	0.42	0.28	0.19	0.33	0.10	0.0	27.54	8.13	42.0	5.10	8.79
4	30.8	0.0	****	23.0	8.20	0.71	0.71	0.38	0.42	0.13	0.0	27.54	7.46	91.5	4.00	7.01
5	30.8	0.0	****	22.0	8.50	1.37	1.37	1.24	0.66	0.27	0.15	30.59	8.82	114.0	6.20	7.02
5-A	30.6	0.0	****	20.0	8.50	1.37	1.37	1.24	0.75	0.37	0.22	30.09	8.06	99.0	7.90	6.59
6	30.6	0.0	****	24.0	6.10	1.54	1.54	0.83	0.66	0.32	0.20	29.95	8.30	90.0	6.50	6.13
7	30.1	0.0	****	20.0	10.20	1.52	0.29	1.26	0.62	0.25	0.14	30.19	9.93	117.0	5.80	5.21
8	30.1	0.0	****	24.0	6.20	0.96	0.07	1.23	0.56	0.19	0.11	30.64	10.89	132.0	5.60	7.22
8-A	30.2	0.0	****	20.0	8.00	0.67	0.03	1.50	0.50	0.18	0.09	31.33	9.59	102.0	6.90	7.01
9	30.4	0.0	****	21.0	8.90	0.78	0.02	1.09	0.50	0.17	0.08	31.87	8.54	99.0	5.00	8.75
10	30.0	0.0	****	22.0	8.50	0.56	0.07	0.97	0.46	0.17	0.09	31.64	9.35	79.5	6.80	7.32
10-A	30.0	0.0	****	21.0	10.20	0.58	0.07	0.85	0.49	0.18	0.09	31.19	8.24	79.5	6.10	7.27
11	30.2	0.0	****	24.0	10.40	0.37	0.09	0.46	0.41	0.15	0.06	30.32	8.89	90.0	5.30	9.61
12	29.0	0.7	****	19.0	20.00	0.31	0.06	0.21	0.57	0.26	0.12	29.64	7.91	85.5	5.10	8.10
13	30.3	1.0	****	19.0	10.90	0.73	0.03	0.07	0.51	0.29	0.14	29.19	9.30	88.5	6.20	10.91
14	29.2	3.9	****	13.0	35.10	0.23	0.10	0.19	0.69	0.41	0.24	26.62	6.28	25.5	7.10	6.54
15	29.6	5.4	****	23.0	18.00	0.25	0.05	0.08	0.4	0.33	0.65	26.95	8.64	60.0	6.60	6.25
15-A	28.9	6.8	****	22.0	19.00	0.25	0.08	0.0	1.11	0.54	0.40	25.75	17.90	405.0	13.70	5.48
16	28.7	7.5	****	23.0	15.00	0.63	0.03	0.0	0.56	0.34	0.23	26.67	7.81	103.0	6.20	7.17

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POTOMAC RIVER DATA FOR JULY 20, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SPCCND (MM)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	27.0	0.0	****	****	8.00	0.76	0.09	0.09	0.24	0.19	0.03	29.60	5.81	96.5	5.20	6.43
P-4	31.6	0.0	****	26.0	7.75	0.62	0.02	0.04	0.21	0.0	0.0	32.53	8.32	27.0	5.60	6.94
1	31.9	0.0	****	25.0	7.75	0.71	0.02	0.04	0.21	0.0	0.0	28.54	3.63	37.5	5.40	7.56
1-A	31.9	0.0	****	25.0	7.00	0.63	0.02	0.04	0.20	0.0	0.0	29.80	6.11	53.0	5.70	8.04
2	31.5	0.0	****	26.0	6.00	0.63	0.02	0.04	0.19	0.0	0.0	29.03	1.21	36.5	6.00	8.09
3	31.6	0.0	****	26.0	12.00	0.82	0.23	0.28	0.38	0.06	0.0	32.14	6.32	75.0	6.60	7.45
4	31.3	0.0	****	26.0	8.50	2.05	1.09	0.32	0.51	0.23	0.14	32.43	2.64	67.5	6.80	6.47
5	31.5	0.0	****	26.0	9.00	2.50	1.24	0.38	0.63	0.30	0.20	35.06	5.16	84.0	9.00	6.01
5-A	31.3	0.0	****	25.0	9.50	2.43	1.02	0.92	0.64	0.28	0.19	36.29	6.19	88.5	9.10	5.61
6	31.1	0.0	****	25.0	9.15	2.70	0.80	1.14	0.60	0.26	0.18	32.24	5.40	96.0	9.90	3.72
7	30.0	0.0	****	25.0	14.00	1.36	0.29	1.22	0.59	0.20	0.12	31.09	2.97	103.5	5.00	6.68
8	30.8	0.0	****	24.0	15.00	1.18	0.19	1.37	0.47	0.18	0.12	31.90	2.37	87.0	6.60	6.91
8-A	30.8	0.0	****	25.0	15.00	1.07	0.17	1.14	0.38	0.17	0.11	33.79	2.21	96.2	5.20	6.80
9	30.9	0.0	****	21.0	14.00	0.84	0.07	0.95	0.48	0.16	0.11	33.79	2.41	85.5	6.90	7.93
10	30.6	0.3	****	22.0	15.00	0.85	0.19	0.89	0.40	0.16	0.11	33.69	2.04	81.0	6.50	7.30
10-B	30.2	0.4	****	15.0	20.00	0.73	0.09	0.69	0.46	0.19	0.12	36.72	3.27	72.0	5.90	6.25
11	30.5	0.4	****	16.0	18.00	0.62	0.03	0.58	0.46	0.19	0.13	36.87	6.66	90.0	5.20	8.55
12	29.7	0.1	****	14.0	20.00	0.60	0.02	0.16	0.54	0.21	0.13	33.79	5.10	57.0	6.60	9.61
13	29.6	7.2	****	15.0	20.00	0.45	0.03	0.08	0.29	0.30	0.20	29.70	3.73	39.0	6.50	9.80
14	29.8	6.9	****	15.0	28.20	0.47	0.13	0.14	0.46	0.32	0.23	27.29	2.45	21.0	7.50	8.27
15	29.2	7.1	****	15.0	19.00	0.96	0.06	0.07	0.76	0.41	0.32	33.90	9.28	273.0	13.20	4.39
15-A	29.3	7.7	****	20.0	15.00	0.44	0.09	0.05	0.42	0.30	0.27	28.85	3.78	70.5	6.00	6.15
16	29.8	8.4	****	29.0	16.00	0.62	0.04	0.06	0.58	0.39	0.26	32.59	6.74	196.5	7.80	6.92

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POTOMAC RIVER DATA FOR JULY 25 1977

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
4-B	33.0	0.0	****	****	7.00	0.69	0.09	0.0	0.26	0.0	0.0	28.59	1.12	42.0	1.90	7.21
4-A	27.7	0.0	7.80	31.0	7.50	0.54	0.03	0.0	0.24	0.0	0.0	30.05	4.10	28.5	2.80	5.23
1	27.8	0.0	7.80	33.0	6.75	0.48	0.06	0.0	0.18	0.0	0.0	29.85	6.01	7.5	3.60	5.49
1-A	27.6	0.0	7.80	29.0	7.50	0.56	0.09	0.05	0.24	0.0	0.0	29.46	6.14	13.5	3.00	6.27
2	27.4	0.0	7.70	29.0	8.00	0.48	0.10	0.12	0.27	0.0	0.0	30.97	5.13	7.5	1.10	6.30
3	25.5	0.0	****	21.0	8.50	0.68	0.23	0.54	0.40	0.10	0.04	27.76	4.13	31.5	2.80	6.06
4	26.8	0.0	7.10	22.0	15.00	1.66	0.95	0.94	0.79	0.34	0.15	30.78	5.52	13.5	2.70	6.78
5	26.7	0.0	7.10	15.0	16.00	1.62	0.09	1.29	0.95	0.35	0.18	32.77	9.68	61.5	2.80	5.71
5-A	24.8	0.0	7.10	18.0	14.00	1.15	0.04	1.53	0.81	0.28	0.13	30.68	6.16	42.0	6.80	6.14
6	25.6	0.0	7.20	15.0	12.00	1.01	0.19	1.65	0.67	0.24	0.12	30.48	7.02	88.5	5.20	6.88
7	27.2	0.0	7.30	22.0	8.50	0.95	0.07	1.52	0.44	0.17	0.11	30.97	6.50	69.0	3.40	5.24
8	26.9	0.0	7.90	20.0	10.00	0.85	0.03	0.98	0.54	0.16	0.10	32.19	7.09	34.5	2.80	7.28
8-A	26.9	0.0	8.20	20.0	7.50	0.91	0.04	0.79	0.51	0.16	0.10	32.73	7.78	68.2	2.20	7.43
9	27.0	0.0	8.40	19.0	10.00	0.72	0.0	0.67	0.58	0.18	0.10	33.21	9.21	76.5	2.90	8.17
10	27.0	0.0	8.40	21.0	10.00	0.60	0.03	0.60	0.51	0.17	0.10	32.65	7.47	110.0	2.70	7.66
10-B	26.9	0.0	8.00	20.0	10.50	0.57	0.03	0.67	0.49	0.20	0.13	31.56	6.82	49.5	1.20	7.16
11	26.8	0.1	7.70	20.0	10.50	0.47	0.05	0.35	0.53	0.28	0.19	31.23	5.48	49.5	1.00	6.64
12	26.7	0.9	8.00	17.0	20.00	0.47	0.0	0.15	0.58	0.29	0.17	28.29	9.19	33.0	1.10	7.39
13	26.8	2.5	7.30	19.0	20.00	0.32	0.05	0.19	0.44	0.34	0.24	24.10	7.63	10.5	1.20	6.63
14	26.8	4.9	7.10	24.0	10.10	0.33	0.08	0.12	0.40	0.30	0.22	26.56	9.52	6.0	0.30	5.58
15	26.7	6.8	7.10	27.0	9.50	0.34	0.08	0.09	0.40	0.27	0.21	27.61	11.98	19.0	0.90	5.63
15-A	26.6	8.1	7.20	25.0	10.00	0.29	0.08	0.05	0.38	0.29	0.22	26.69	12.59	12.0	1.00	5.05
16	26.6	8.7	7.20	30.0	7.50	0.32	0.07	0.0	0.38	0.28	0.22	24.59	11.64	13.5	0.20	5.10

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POTOMAC RIVER DATA FOR JULY 27, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPOA (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-R	25.0	0.0	****	****	8.50	0.46	0.0	0.0	0.29	0.0	0.0	31.37	2.76	52.5	1.30	7.97
P-4	27.5	0.0	8.10	31.0	6.00	0.35	0.0	0.0	0.20	0.0	0.0	33.83	3.35	36.0	2.20	7.48
1	27.8	0.0	8.20	34.0	6.00	0.38	0.0	0.0	0.21	0.0	0.0	30.15	2.29	30.0	2.80	8.25
1-A	27.0	0.0	7.80	36.0	4.50	0.37	0.06	0.0	0.21	0.0	0.0	30.73	2.50	19.5	2.40	6.96
2	27.1	0.0	7.80	30.0	5.50	0.40	0.07	0.0	0.22	0.0	0.0	31.27	1.27	27.0	2.20	6.63
3	27.6	0.0	7.90	27.0	7.50	0.58	0.11	0.42	0.33	0.04	0.0	31.63	2.98	52.5	6.10	7.62
4	27.5	0.0	7.50	27.0	9.00	0.99	0.51	0.43	0.50	0.17	0.08	33.22	2.74	63.5	5.60	6.12
5	27.1	0.0	7.50	24.0	8.50	1.21	0.61	0.40	0.57	0.25	0.13	32.99	2.87	37.5	5.80	5.52
5-A	27.1	0.0	7.40	23.0	7.50	1.28	0.62	0.35	0.65	0.22	0.12	33.13	4.26	67.5	7.50	5.66
6	26.3	0.0	7.40	23.0	9.20	1.30	0.59	0.42	0.64	0.20	0.11	32.59	6.58	77.7	5.60	5.19
7	25.4	0.0	7.60	19.0	9.90	0.90	0.18	1.46	0.54	0.16	0.09	32.34	5.77	96.0	6.60	6.12
8	26.1	0.0	7.60	22.0	7.50	0.82	0.10	1.49	0.50	0.14	0.09	34.89	6.18	87.0	5.60	5.71
8-A	25.9	0.0	8.20	22.0	9.00	0.73	0.0	1.09	0.53	0.14	0.09	31.47	4.36	123.0	6.70	8.36
9	25.9	0.0	8.40	22.0	7.50	0.78	0.0	0.97	0.47	0.14	0.09	33.27	3.59	118.5	6.20	8.18
10	25.8	0.0	8.60	23.0	8.50	0.41	0.0	0.72	0.50	0.14	0.09	32.20	1.24	129.0	6.40	8.53
10-B	25.7	0.0	8.80	19.0	12.00	0.61	0.0	0.49	0.55	0.16	0.11	32.10	2.48	120.0	7.70	9.73
11	25.5	0.0	8.50	18.0	11.50	0.91	0.0	0.52	0.67	0.17	0.13	32.10	12.23	112.5	7.60	8.37
12	25.3	0.4	8.00	12.0	20.00	0.41	0.0	0.28	0.66	0.27	0.17	32.20	8.26	55.5	7.70	7.67
13	25.6	1.9	7.90	12.0	20.00	0.40	0.03	0.14	0.59	0.35	0.24	28.53	8.71	33.0	7.20	7.51
14	25.8	3.8	7.50	12.0	20.00	0.44	0.08	0.19	0.56	0.35	0.26	27.63	8.42	16.5	1.90	5.60
15	25.5	5.6	7.60	18.0	14.00	0.36	0.10	0.15	0.45	0.29	0.24	29.68	13.25	33.0	3.40	6.11
15-A	25.2	7.0	7.50	22.0	15.00	0.32	0.11	0.10	0.45	0.30	0.24	28.19	12.82	18.0	1.20	5.42
16	25.3	8.2	7.40	23.0	12.00	0.32	0.12	0.05	0.39	0.29	0.24	29.07	12.36	25.5	2.60	6.95

POTOMAC RIVER DATA FOR AUGUST 1, 1977

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	28.0	0.0	****	****	5.00	0.41	0.0	0.0	0.23	0.0	0.0	39.86	8.62	12.0	1.00	7.38
P-6	27.0	0.0	****	35.0	5.00	0.36	0.0	0.0	0.17	0.0	0.0	32.59	6.07	46.5	1.20	7.35
1	27.0	0.0	****	35.0	5.00	0.34	0.0	0.0	0.17	0.0	0.0	32.54	7.93	12.0	2.10	8.77
1-A	26.5	0.0	****	30.0	7.50	0.33	0.0	0.0	0.17	0.0	0.0	32.54	6.02	16.5	2.80	7.99
2	26.0	0.0	****	26.0	6.50	0.42	0.04	0.0	0.18	0.0	0.0	31.17	7.15	12.0	2.80	6.77
3	26.5	0.0	****	22.0	15.00	0.72	0.29	0.53	0.26	0.11	0.04	30.35	8.55	16.5	4.00	5.37
4	27.0	0.0	****	22.0	15.00	1.06	0.46	0.91	0.37	0.19	0.09	32.64	9.14	22.5	6.10	5.47
5	28.0	0.0	****	26.0	8.50	1.13	0.40	1.39	0.56	0.25	0.15	33.59	9.97	34.5	6.30	6.54
5-A	27.5	0.0	****	28.0	7.50	1.04	0.29	1.71	0.37	0.21	0.14	33.35	11.16	24.0	5.50	6.43
6	27.5	0.0	****	29.0	6.90	0.99	0.18	1.76	0.33	0.18	0.11	32.03	10.86	43.5	6.50	*****
7	27.0	0.0	****	****	10.50	0.89	0.04	1.60	0.69	0.16	0.09	31.88	9.96	68.0	6.70	6.05
8	27.5	0.0	****	23.0	8.00	0.76	0.0	1.25	0.46	0.15	0.09	32.54	19.35	22.5	6.50	7.76
8-A	****	0.0	****	25.0	7.50	0.71	0.0	0.93	0.52	0.16	0.11	33.71	11.82	87.0	5.00	9.20
9	27.0	0.0	****	32.0	9.70	0.69	0.0	0.71	0.50	0.16	0.10	32.85	10.33	60.0	6.00	8.62
10	27.5	0.0	****	25.0	7.50	0.65	0.0	0.50	0.47	0.16	0.11	31.99	10.04	66.0	6.80	10.34
10-B	26.2	0.0	****	26.0	6.50	0.60	0.0	0.38	0.47	0.16	0.12	32.85	10.42	76.5	5.00	11.60
11	27.2	0.0	****	24.0	10.00	0.52	0.0	0.17	0.54	0.20	0.14	33.20	11.26	58.5	6.90	10.87
12	26.2	1.1	****	15.0	17.00	0.47	0.0	0.0	0.61	0.24	0.16	31.52	10.31	30.0	3.90	11.23
13	27.5	1.8	****	19.0	20.00	0.40	0.0	0.0	0.58	0.32	0.23	29.99	7.86	36.0	7.50	10.06
14	27.3	4.4	****	20.0	15.00	0.41	0.02	0.15	0.51	0.34	0.26	29.27	8.80	16.5	3.70	7.58
15	26.6	6.9	****	20.0	15.00	0.36	0.04	0.13	0.43	0.30	0.23	27.19	7.96	63.5	2.10	9.52
15-A	26.4	7.9	****	22.0	18.00	0.41	0.03	0.08	0.48	0.31	0.24	27.19	7.39	14.5	1.80	6.04
16	****	****	****	****	9.50	0.44	0.04	0.08	0.43	0.28	0.23	29.27	9.32	10.5	3.40	6.71

POTOMAC RIVER DATA FOR AUGUST 3, 1977

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	27.8	0.0	****	****	10.00	0.44	0.09	0.14	0.25	0.04	0.0	31.55	4.45	25.5	1.70	7.37
P-4	28.0	0.0	****	24.0	7.00	0.45	0.02	0.06	0.18	0.03	0.0	30.30	2.95	33.0	2.40	7.53
1	27.9	0.0	****	32.0	5.90	0.36	0.02	0.04	0.16	0.02	0.0	30.00	3.20	27.0	3.20	5.79
1-A	27.2	0.0	****	32.0	6.00	0.47	0.10	0.0	0.19	0.03	0.0	31.40	3.70	28.5	4.20	6.30
2	27.0	0.0	****	30.0	6.00	0.53	0.12	0.0	0.20	0.03	0.0	31.25	2.55	29.5	4.00	5.46
3	27.8	0.0	****	28.0	9.00	1.48	0.81	0.41	0.55	0.20	0.10	30.80	3.35	46.5	5.60	2.84
4	27.0	0.0	****	30.0	6.00	1.26	0.47	1.44	0.56	0.22	0.16	31.65	4.35	57.0	7.40	2.62
5	27.0	0.0	****	30.0	5.50	1.30	0.22	1.90	0.51	0.20	0.16	31.70	5.60	66.0	6.30	2.79
5-A	27.0	0.0	****	24.0	8.00	1.16	0.26	1.64	0.56	0.19	0.13	32.00	5.75	85.5	6.40	3.50
6	27.0	0.0	****	24.0	7.62	1.08	0.12	1.62	0.46	0.15	0.11	28.63	3.88	69.0	6.40	5.11
7	27.2	0.0	****	15.0	9.50	0.98	0.10	1.13	0.49	0.15	0.11	32.05	6.05	103.5	5.20	6.61
8	27.2	0.0	****	20.0	8.50	0.79	0.09	0.77	0.53	0.14	0.12	32.85	6.90	126.5	5.30	4.59
8-A	27.2	0.0	****	24.0	8.00	0.73	0.10	0.65	0.60	0.20	0.15	32.40	6.30	103.5	5.20	6.46
9	27.0	0.0	****	24.0	7.00	0.79	0.12	0.57	0.57	0.17	0.14	31.25	5.75	97.5	5.40	6.49
10	26.8	0.0	****	20.0	7.00	0.69	0.16	0.51	0.51	0.18	0.15	31.70	6.20	76.5	6.30	7.11
10-B	26.4	0.6	****	16.0	10.50	0.68	0.08	0.16	0.57	0.16	0.16	31.85	6.40	107.0	5.80	7.19
11	26.7	1.2	****	11.0	20.00	0.95	0.06	0.07	0.62	0.23	0.17	28.99	3.40	85.5	5.20	7.12
12	26.5	2.1	****	12.0	20.20	0.39	0.04	0.04	0.63	0.29	0.21	31.55	6.60	75.0	2.90	5.51
13	26.8	4.2	****	12.0	25.00	0.36	0.10	0.17	0.58	0.37	0.28	28.25	4.10	22.5	1.30	5.21
14	26.7	6.6	****	19.0	19.10	0.33	0.09	0.18	0.50	0.29	0.23	26.89	4.58	18.0	1.30	5.71
15	26.8	8.1	****	18.0	10.00	0.31	0.10	0.16	0.47	0.29	0.24	26.85	3.40	30.0	1.90	5.50
15-A	26.6	8.8	****	19.0	10.00	0.30	0.12	0.11	0.41	0.29	0.25	26.69	3.20	26.0	1.80	5.89
16	26.5	9.9	****	****	10.25	0.31	0.13	0.07	0.36	0.25	0.21	26.65	3.20	16.5	1.60	5.85

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POTOMAC RIVER DATA FOR AUGUST 22, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-P	25.0	0.0	****	****	19.00	0.62	0.0	0.0	0.79	0.04	0.0	34.98	7.84	91.5	3.40	7.78
P-4	26.2	0.0	8.80	21.0	6.00	0.62	0.0	0.0	0.22	0.0	0.0	36.81	6.61	54.0	3.70	10.19
1	26.2	0.0	8.70	23.0	8.50	0.65	0.0	0.0	0.70	0.0	0.0	35.52	5.89	48.0	3.40	9.93
1-A	26.2	0.0	8.40	23.0	8.50	0.55	0.0	0.0	0.70	0.0	0.0	38.34	5.68	66.5	3.40	9.14
2	26.0	0.0	8.00	23.0	15.00	0.63	0.07	0.05	0.22	0.0	0.0	34.64	1.98	69.5	2.40	7.61
3	26.1	0.0	7.60	17.0	19.00	1.25	0.51	0.69	0.46	0.14	0.08	36.56	6.12	79.5	7.10	6.34
4	25.8	0.0	7.30	18.0	20.00	1.61	0.79	1.52	0.68	0.24	0.12	39.04	10.26	79.5	9.50	3.73
5	25.8	0.0	7.30	20.0	8.50	1.33	0.37	1.85	0.58	0.18	0.11	36.29	7.00	97.5	8.30	5.04
5-A	26.0	0.0	7.50	20.0	19.00	1.10	0.03	1.81	0.50	0.12	0.06	32.12	5.68	130.5	6.60	6.93
6	26.2	0.0	7.80	14.0	18.25	1.06	0.02	1.60	0.69	0.13	0.07	36.44	9.03	168.8	5.60	6.96
7	26.0	0.0	8.00	11.0	20.00	1.19	0.0	1.65	0.69	0.12	0.07	33.60	7.50	172.5	5.10	8.02
8	25.9	0.0	8.90	11.0	22.00	1.17	0.0	0.54	0.68	0.18	0.13	36.99	9.72	276.0	5.30	10.07
8-A	25.9	0.0	9.10	12.0	25.00	1.44	0.0	0.18	0.76	0.23	0.16	36.17	11.55	306.0	5.40	9.61
9	26.0	0.0	9.10	12.0	25.00	1.25	0.0	0.19	0.75	0.24	0.17	35.92	10.95	264.0	5.00	10.19
10	25.9	0.0	9.00	11.0	25.50	1.23	0.0	0.09	0.74	0.26	0.21	37.55	11.89	283.5	5.50	8.99
10-A	26.0	0.4	8.70	18.0	20.00	0.88	0.0	0.0	0.79	0.37	0.29	35.92	9.72	198.0	5.70	8.34
11	26.0	1.2	8.30	15.0	25.00	0.72	0.0	0.0	0.73	0.41	0.34	35.09	9.23	*****	3.20	7.26
12	25.8	2.4	8.00	13.0	30.00	0.53	0.0	0.13	0.68	0.43	0.36	33.11	7.26	81.0	1.80	7.16
13	25.9	4.2	7.60	13.0	26.00	0.44	0.05	0.32	0.68	0.47	0.36	29.01	2.96	27.0	1.00	5.91
14	26.0	6.6	7.50	24.0	19.00	0.36	0.03	0.71	0.69	0.37	0.33	27.68	1.78	15.0	0.50	5.29
15	26.2	8.5	7.40	24.0	18.00	0.36	0.03	0.70	0.66	0.36	0.31	28.57	1.63	13.5	0.80	4.98
15-A	26.2	8.9	7.30	24.0	15.00	0.36	0.02	0.70	0.69	0.35	0.31	29.70	5.13	21.0	1.40	5.33
16	26.1	9.9	7.50	26.0	19.00	0.37	0.03	0.28	0.66	0.34	0.29	27.59	2.71	19.5	1.00	4.75

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POTOMAC RIVER DATA FOR AUGUST 24, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SPECCND (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	26.0	0.0	****	****	8.00	0.48	0.02	0.06	0.25	0.06	0.0	31.44	4.08	79.5	4.00	7.91
P-4	26.0	0.0	7.60	32.0	7.50	0.50	0.06	0.0	0.22	0.05	0.0	29.34	2.76	58.5	2.90	6.03
1	26.0	0.0	7.40	31.0	6.25	0.48	0.03	0.0	0.18	0.04	0.0	29.15	3.16	46.5	3.00	6.74
1-A	26.0	0.0	7.80	31.0	6.50	0.42	0.02	0.0	0.15	0.04	0.0	31.27	2.21	45.5	2.70	7.83
2	26.0	0.0	7.60	33.0	8.00	0.44	0.05	0.0	0.18	0.09	0.0	34.51	3.47	46.5	2.50	7.01
3	25.5	0.0	7.20	33.0	15.00	0.89	0.39	0.77	0.47	0.13	0.08	37.40	4.73	60.0	5.10	7.68
4	26.0	0.0	7.10	18.0	10.25	1.38	0.46	1.29	0.53	0.20	0.16	35.38	5.41	66.5	7.00	2.57
5	26.5	0.0	7.00	12.0	10.00	1.16	0.19	1.92	0.50	0.15	0.10	31.97	8.26	112.5	7.00	4.34
5-A	26.0	0.0	7.00	19.0	10.00	1.24	0.31	1.96	0.58	0.18	0.11	32.44	9.68	97.0	7.40	3.10
6	26.0	0.0	7.10	16.0	10.12	1.09	0.08	1.87	0.50	0.16	0.09	32.26	10.84	138.7	6.40	6.72
7	27.0	0.0	****	19.0	10.00	1.12	0.02	1.69	0.69	0.13	0.08	31.97	6.72	147.0	5.50	6.28
8	27.0	0.0	8.40	12.0	12.00	1.10	0.0	0.96	0.60	0.17	0.12	32.26	7.71	261.0	5.00	9.50
8-A	26.5	0.0	9.00	12.0	10.25	1.27	0.0	0.35	0.71	0.22	0.16	31.29	8.93	306.0	9.00	10.11
9	26.5	0.0	9.30	7.0	15.00	1.26	0.0	0.0	0.83	0.26	0.17	25.25	3.42	303.0	6.40	11.38
10	26.0	0.0	9.[illegible]	11.0	15.00	1.33	0.0	0.19	0.72	0.23	0.16	32.44	8.38	312.0	6.60	9.07
10-A	26.5	1.0	8.90	13.0	10.50	1.01	0.0	0.0	0.76	0.33	0.26	35.57	7.23	228.0	3.00	*****
11	26.5	1.4	8.50	18.0	15.00	0.80	0.0	0.0	0.71	0.36	0.31	33.76	7.82	168.0	3.30	*****
12	26.5	2.4	7.40	18.0	10.25	0.76	0.0	0.0	0.66	0.39	0.31	32.21	5.63	118.5	3.00	6.83
13	26.5	3.8	7.30	18.0	18.00	0.10	0.02	0.17	0.60	0.42	0.35	28.96	2.82	51.0	1.60	8.78
14	26.6	6.0	7.40	20.0	10.00	0.40	0.05	0.33	0.52	0.39	0.33	27.64	2.71	12.0	1.40	9.17
15	26.9	7.9	7.30	32.0	8.50	0.40	0.04	0.32	0.47	0.35	0.32	28.77	2.98	24.0	1.00	9.56
15-A	26.8	9.2	7.00	26.0	8.50	0.36	0.03	0.30	0.43	0.35	0.30	28.73	2.20	21.0	1.20	9.49
16	26.9	9.9	7.40	30.0	6.50	0.41	0.02	0.29	0.51	0.43	0.38	27.69	1.16	24.0	1.30	9.66

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PUTOMAC RIVER DATA FOR AUGUST 29, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	27.0	0.0	****	****	6.50	0.47	0.0	0.0	0.22	0.04	0.01	32.47	2.27	34.5	1.00	7.62
P-4	28.0	0.0	8.00	27.0	6.00	0.45	0.0	0.0	0.19	0.04	0.01	33.35	1.63	28.5	1.80	9.05
1	29.0	0.0	8.30	26.0	6.00	0.49	0.0	0.0	0.18	0.03	0.01	29.49	0.0	24.0	6.20	11.02
1-A	27.0	0.0	8.30	25.0	7.50	0.48	0.0	0.0	0.21	0.04	0.01	27.69	2.16	40.5	6.40	9.69
2	27.0	0.0	7.60	11.0	8.00	0.51	0.04	0.11	0.20	0.05	0.01	27.67	2.28	37.5	1.50	8.37
3	28.0	0.0	7.60	16.0	7.09	1.26	0.62	0.65	0.45	0.15	0.08	31.14	3.32	93.0	8.60	7.73
4	28.0	0.0	7.60	15.0	6.50	1.13	0.52	0.48	0.47	0.15	0.09	31.28	5.05	90.0	8.60	7.86
5	28.0	0.0	7.30	19.0	7.25	1.59	0.68	1.59	0.60	0.24	0.10	33.60	1.72	90.0	10.00	5.61
5-A	28.0	0.0	7.30	22.0	5.50	1.26	0.33	1.60	0.53	0.17	0.11	32.28	5.05	121.5	9.70	6.81
6	28.0	0.0	7.60	21.0	5.50	1.12	0.29	1.72	0.47	0.14	0.08	31.64	4.54	129.0	9.20	6.38
7	27.0	0.0	7.60	13.0	7.50	1.18	0.07	1.59	0.53	0.12	0.06	32.83	5.06	151.5	8.40	7.35
8	27.0	0.0	7.90	14.0	6.50	1.19	0.0	1.47	0.50	0.11	0.06	32.10	5.02	180.0	10.20	9.30
8-A	27.0	0.0	8.60	10.0	8.00	1.26	0.0	0.48	0.70	0.17	0.13	35.20	7.82	190.5	10.80	10.82
9	27.0	0.0	8.90	12.0	9.00	1.38	0.0	0.35	0.80	0.18	0.12	32.35	6.88	261.0	11.00	10.51
10	27.0	0.0	9.20	13.0	12.00	1.33	0.0	0.11	0.76	0.21	0.16	32.19	7.69	300.0	10.50	10.36
10-B	27.2	0.5	9.20	12.0	14.00	1.11	0.0	0.0	0.85	0.28	0.21	32.78	7.24	294.0	10.20	10.46
11	26.8	1.1	9.10	11.0	10.00	0.89	0.0	0.0	0.85	0.29	0.31	32.92	6.58	199.5	7.60	11.38
12	26.3	2.2	7.80	15.0	9.00	0.63	0.0	0.0	0.76	0.44	0.36	32.05	4.43	157.5	6.90	9.39
13	27.1	3.4	7.90	12.0	14.00	0.57	0.0	0.0	0.70	0.44	0.37	32.37	5.34	111.0	5.00	9.72
14	26.3	5.5	****	15.0	18.25	0.39	0.0	0.23	0.57	0.44	0.37	27.77	2.55	76.0	2.60	9.84
15	26.6	7.7	7.50	****	11.00	0.38	0.0	0.31	0.51	0.38	0.33	26.67	2.45	24.0	2.00	6.05
15-A	26.0	8.6	7.10	22.0	6.00	0.35	0.0	0.20	0.51	0.38	0.33	26.95	0.0	27.0	1.20	6.20
16	28.3	9.3	7.60	24.0	5.50	0.33	0.0	0.20	0.47	0.38	0.35	27.90	0.0	22.5	2.40	6.43

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POTOMAC RIVER DATA FOR AUGUST 31, 1977

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STATION	TEMP (C)	SALINITY (PPT)	PH	SPECCND (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	P'(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
P-8	29.0	0.0	****	****	6.30	0.47	0.03	0.85	0.77	0.06	0.01	92.13	9.47	19.5	7.80	7.22
P-6	29.1	0.0	7.60	24.0	5.50	0.61	0.0	0.0	0.18	0.03	0.0	91.76	5.69	10.0	5.00	7.15
1	29.3	0.0	8.30	24.0	4.50	0.40	0.0	0.0	0.15	0.07	0.0	90.39	2.95	21.0	3.30	8.22
1-A	29.3	0.0	7.90	****	5.50	0.46	0.02	0.0	0.18	0.03	0.0	90.19	5.61	33.0	5.80	7.66
2	27.3	0.0	7.50	21.0	7.00	0.49	0.10	0.04	0.17	0.03	0.01	29.51	4.05	25.5	2.90	6.75
3	28.7	0.0	****	21.0	6.00	1.76	1.01	1.07	0.16	0.24	0.16	32.09	5.35	68.0	9.20	5.26
4	28.8	0.0	7.80	23.0	5.50	1.39	0.56	1.64	0.55	0.22	0.16	93.71	6.58	75.0	8.50	2.80
5	28.8	0.0	7.10	21.0	5.50	1.26	0.26	1.02	0.47	0.15	0.10	99.24	7.02	116.0	7.60	5.37
5-A	28.3	0.0	7.10	20.0	6.50	1.16	0.21	1.75	0.43	0.14	0.09	32.81	7.45	91.5	6.70	6.29
6	29.0	0.0	7.50	16.0	7.24	1.59	0.84	1.68	0.46	0.11	0.06	30.66	5.98	111.0	8.00	6.44
7	28.1	0.0	7.80	19.0	6.00	0.97	0.05	1.44	0.31	0.10	0.08	32.66	6.01	137.5	9.80	7.48
8	27.7	0.0	7.80	19.0	9.50	1.20	0.19	0.06	0.67	0.19	0.13	33.10	7.26	176.3	9.40	9.83
8-A	28.0	0.0	8.30	19.0	9.50	1.22	0.21	0.99	0.68	0.19	0.14	33.00	8.00	187.5	9.70	9.67
9	28.0	0.0	8.70	17.0	8.00	1.24	0.17	0.23	0.72	0.19	0.13	32.90	6.76	172.5	9.10	7.12
10	27.8	0.2	8.90	12.0	9.00	1.21	0.26	0.15	0.72	0.21	0.16	93.19	9.39	195.0	9.90	9.60
10-A	27.7	1.2	9.00	12.0	9.50	0.97	0.09	0.0	0.77	0.35	0.29	32.81	9.23	171.0	7.90	9.71
11	26.9	1.4	8.50	12.0	10.50	0.92	0.03	0.0	0.77	0.73	0.33	32.22	9.80	168.5	6.30	7.92
12	27.5	2.7	8.20	17.0	15.00	0.59	0.09	0.0	0.69	0.44	0.35	31.59	6.55	96.0	4.20	8.08
13	26.8	4.0	7.50	19.0	15.00	0.60	0.03	0.17	0.62	0.43	0.35	29.32	5.56	69.5	3.80	6.41
14	26.8	6.6	7.40	18.0	10.00	0.50	0.03	0.32	0.56	0.42	0.32	27.71	4.36	19.5	1.70	6.28
15	27.0	8.7	7.30	22.0	5.50	0.52	0.09	0.38	0.43	0.34	0.31	28.59	4.24	16.5	1.60	9.93
15-A	27.1	9.3	7.30	30.0	4.00	0.50	0.03	0.29	0.49	0.33	0.29	26.32	3.27	15.0	1.80	6.24
16	27.9	10.6	7.10	25.0	3.50	0.38	0.06	0.26	0.38	0.29	0.26	27.10	2.20	17.0	2.60	9.84

POTOMAC RIVER DATA FOR SEPTEMBER 6,1977

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
9-B	28.0	0.0	****	****	5.95	0.46	0.03	0.0	0.20	0.0	0.0	37.62	5.71	66.5	2.00	7.61
9-A	29.5	0.0	8.40	26.0	5.50	0.61	0.0	0.0	0.16	0.0	0.0	36.01	1.39	****	1.60	9.15
1	29.9	0.0	8.50	25.0	5.10	0.43	0.0	0.0	0.09	0.0	0.0	36.55	1.68	37.5	2.80	9.60
1-A	29.2	0.0	8.70	26.0	5.00	0.47	0.04	0.0	0.16	0.0	0.0	37.51	1.53	48.0	3.60	10.76
2	28.8	0.0	8.30	25.0	5.50	0.47	0.0	0.0	0.17	0.0	0.0	36.06	2.92	58.5	3.80	9.91
3	28.5	0.0	7.20	25.0	7.10	1.09	0.62	0.78	0.36	0.13	0.08	36.16	2.63	66.5	5.20	6.09
4	29.3	0.0	7.20	26.0	6.00	2.12	1.44	1.26	0.66	0.31	0.22	37.77	5.66	91.5	7.40	4.71
5	29.0	0.0	7.20	29.0	6.00	1.68	0.72	1.47	0.64	0.16	0.11	35.76	4.25	86.0	7.60	5.29
5-A	28.6	0.0	7.10	15.0	7.80	1.78	0.55	1.78	0.61	0.15	0.10	36.60	5.69	73.5	6.60	4.08
6	28.7	0.0	7.20	20.0	5.50	1.06	0.28	1.76	0.18	0.13	0.09	36.29	5.65	76.5	5.90	4.54
7	29.2	0.0	7.60	22.0	6.50	1.01	0.12	1.62	0.37	0.13	0.09	37.48	7.98	95.0	5.10	6.25
8	29.7	0.0	7.70	****	7.50	0.46	0.12	0.95	0.53	0.23	0.17	36.16	5.30	109.5	5.10	4.92
8-A	29.7	0.0	8.00	15.0	6.50	0.90	0.05	0.79	0.16	0.23	0.17	36.19	7.13	165.5	5.60	5.69
9	28.6	0.0	8.60	15.0	7.00	0.85	0.16	0.59	0.69	0.22	0.16	36.95	7.28	180.0	5.20	7.01
10	28.8	0.4	8.30	18.0	6.95	0.72	0.03	0.73	0.57	0.24	0.17	35.00	6.34	130.5	5.70	5.83
10-B	28.8	1.1	8.50	16.0	6.50	0.76	0.05	0.17	0.71	0.27	0.21	36.06	7.92	180.0	5.10	9.60
11	28.8	1.6	8.80	11.0	5.50	0.69	0.03	0.0	0.69	0.28	0.21	36.65	8.51	186.0	6.30	10.35
12	29.0	2.3	8.90	15.0	6.00	0.55	0.01	0.0	0.68	0.32	0.25	33.96	8.02	169.5	5.10	11.33
13	28.9	2.9	8.70	15.0	19.00	0.71	0.05	0.0	1.06	0.54	0.45	35.76	11.63	259.5	10.70	14.15
14	28.6	6.1	7.60	23.0	8.67	0.91	0.03	0.20	0.69	0.36	0.29	29.16	7.82	187.5	3.60	6.25
15	29.2	7.7	7.60	26.0	7.50	0.92	0.05	0.19	0.65	0.33	0.28	33.27	6.56	60.5	2.50	7.99
15-A	29.2	9.0	7.60	30.0	5.25	0.26	0.03	0.21	0.38	0.31	0.26	29.60	0.19	27.5	1.60	9.97
16	28.1	9.8	7.60	36.0	5.00	0.23	0.03	0.18	0.37	0.29	0.26	29.86	1.83	16.5	1.50	6.59

POTOMAC RIVER DATA FOR SEPTEMBER 8,1977

STATION	TEMP (C)	SALINITY (PPT)	PH	SECCHI (IN)	TURBIDITY	TKN (MG/L)	NH3 (MG/L)	NO2+NO3 (MG/L)	TPO4 (MG/L)	PI (MG/L)	PI(F) (MG/L)	TC (MG/L)	TOC (MG/L)	CHLORO (UG/L)	BOD5 (MG/L)	DO (MG/L)
F-8	27.0	0.0	****	****	10.00	0.46	0.07	0.07	0.21	0.05	0.04	34.60	12.29	45.0	2.00	7.70
F-4	27.0	0.0	7.40	24.0	7.50	0.43	0.11	0.07	0.21	0.05	0.0	31.89	12.00	42.0	2.60	5.63
1	27.0	0.0	7.40	24.0	8.50	0.41	0.13	0.06	0.21	0.05	0.0	31.95	5.85	37.5	2.70	5.78
1-A	27.0	0.0	7.30	25.0	6.00	0.40	0.17	0.0	0.20	0.04	0.0	31.31	10.46	40.5	1.80	4.92
2	27.0	0.0	7.40	24.0	8.50	0.27	0.13	0.0	0.20	0.04	0.0	32.18	11.33	49.5	2.40	6.18
3	27.0	0.0	7.00	19.0	7.75	1.05	0.59	0.71	0.47	0.22	0.15	30.39	9.97	58.5	5.30	3.88
4	27.5	0.0	6.85	25.0	5.50	1.43	1.43	0.98	0.92	0.60	0.43	33.19	12.58	69.0	9.40	2.54
5	27.5	0.0	6.90	31.0	4.00	1.83	1.89	1.22	1.17	0.84	0.71	33.77	10.93	55.5	11.80	1.76
5-A	28.0	0.0	6.90	34.0	4.50	1.35	1.20	1.64	0.71	0.39	0.32	31.69	11.32	58.5	11.20	3.82
6	27.5	0.0	6.90	24.0	9.75	0.76	0.41	1.80	0.49	0.19	0.14	28.58	16.24	75.0	6.60	3.76
7	27.5	0.0	6.90	24.0	7.50	0.72	0.17	1.82	0.36	0.16	0.12	29.91	12.30	67.5	4.60	5.19
8	27.4	0.2	7.25	18.0	7.00	0.54	0.09	1.42	0.43	0.18	0.14	30.72	12.38	72.0	4.70	4.00
8-A	27.4	0.2	7.00	18.0	9.25	0.45	0.07	1.20	0.47	0.25	0.17	30.97	11.44	85.5	5.00	3.09
9	27.3	0.3	7.20	19.0	6.50	0.42	0.08	1.07	0.47	0.23	0.19	30.43	10.88	79.5	4.60	4.16
10	27.3	0.4	7.20	19.0	7.25	0.29	0.06	0.85	0.56	0.28	0.23	31.06	11.51	100.5	4.90	2.27
10-A	26.9	1.3	7.60	16.0	6.50	0.54	0.11	0.30	0.68	0.33	0.26	31.98	12.29	130.5	4.90	5.18
11	27.0	2.1	7.65	15.0	7.00	0.39	0.10	0.10	0.63	0.33	0.27	31.21	11.62	120.0	3.60	4.63
12	27.1	3.2	7.70	19.0	10.00	0.28	0.09	0.09	0.47	0.39	0.32	29.71	10.07	82.5	3.10	6.37
13	26.9	3.4	7.65	20.0	9.00	0.27	0.07	0.10	0.62	0.40	0.34	29.89	11.47	97.0	3.40	6.51
14	27.1	6.3	7.20	22.0	15.10	0.27	0.07	0.22	0.51	0.39	0.30	26.61	8.31	22.5	1.60	5.46
15	26.5	7.3	7.40	24.0	8.25	0.32	0.05	0.21	0.45	0.33	0.31	29.32	9.66	22.5	1.80	4.42
15-A	26.3	9.8	7.40	28.0	6.00	0.31	0.04	0.18	0.40	0.31	0.28	27.59	8.90	19.5	1.20	6.40
16	26.8	10.0	7.20	28.0	5.50	0.29	0.06	0.20	0.43	0.34	0.31	27.87	9.48	27.0	1.70	4.92